CHIROPRACTIC ADJUSTMENTS AND COGNITIVE FUNCTION

by

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A THESIS

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Chiropractic has been around for 125+ years helping regulate the nervous system, spinal adjustments can help relieve chronic/nerve pain, realigning the vertebra, which in turn helps the pinched nerve to relax and no longer send out pain signals. Likely this is due to improvement in neural transmission, suggesting that spinal manipulation may offer more than simply pain relief. In this study we tested whether chiropractic adjustments affected cognition. We tested a group of patients who got spinal adjustments and a group who only received therapy such as postural rehabilitation, interferential current, or ultrasound. This small sample size participated in this study by testing their auditory memory, visual memory, and problem-solving skills before and after a specified treatment. We found a significant decrease in pain after treatment, but results showed no significant improvements in cognition. While the current results did not support a change in cognition this may be partially due to the small sample sizes.

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Introduction

Chiropractic care and spinal manipulation has been shown to help regulate the nervous system. Adjustments have been shown to help alleviate chronic pain, decrease symptoms of depression, and can help with asthma. These effects may be because when a vertebra is misaligned a nerve can become ‘pinched’ or ‘impinged’ and a signal is sent to the brain for processing to relay the message of pain. After an adjustment a patient may show a decrease in pain which can improve the symptoms of chronic pain and depression. While a decrease in pain could be held responsible for these improvements, these positive improvements could also be reflective of an overall improvement with an increase in neural transmission. The positive effects that spinal manipulation offers may not be limited to pain but may positively affect cognitive function. While there has been quite a bit of research on how chiropractic care can help pain in the body and spine, there has been little to no research on how chiropractic may help cognitive function. The goal of this study is to address previous research that has been done and test the effect of spinal manipulation and pain on cognition.

Chiropractic care has been shown to help assist the rehabilitation of the lumbar spine by improving function and decreasing symptoms such as pain (Triano et al., 1997). Patients in a previous study reported a drastic decrease in pain, and their mobility improved significantly (MacPherson et al., 2015). Most people when seeing a chiropractor come when they are in an immense amount of pain and it’s commonly their lower back. This pain in their back disrupts their daily lives and can cause leg and hip pain as well. While there are still many sources on the internet to claim that chiropractic will cause a stroke and has no physical benefit to the person (Cassidy et al., 2009), there have been studies to show that chiropractic care can help with low back pain, neck pain, depression, and may help with asthma (Kaminskyj et al., 2010; Kiani et al., 2020; Meade et al., 1990; Palmgren et al., 2006).

Studies have recently shown that chiropractic manipulation can help regulate the nervous system by activating “the parasympathetic nervous system to counterbalance the activity of the sympathetic system” therefore acting as an antidepressant therapy (Kiani et al., 2020). Depression and pain go hand in hand causing a chemical imbalance in the brain. This chemical imbalance can be improved with manipulation of the spine as this alters the spinal biomechanics and activates the paraspinal sensory neurons. The biomechanical changes would “modulate paravertebral sensory neuron signals,” and therefore alter the way that the brain is communicating with the body (Pickar & Bolton, 2012).

The nervous system is made up of billions of neurons arranged in a specific network that can carry electrical and chemical messages to and from the brain. These messages are transmitted into something the body can translate into a body movement such as fight, flight, or freeze. Pain signals are processed in the parietal cortex as well as “taste, touch, temperature and pain, and also in the understanding of numbers, awareness of the body and feeling of space” (Australia, 2022). Pain is an extremely complex construct including emotional, sensorial, and cognitive aspects, although not all these components share the same neural networks (Gallace & Bellan, 2018). All four lobes of the brain are connected and transmit information via the thalamus located deep inside the brain. While the thalamus is responsible for the transmitting of information it is also responsible for controlling movements and memory (Gallace & Bellan, 2018). If this part of the brain were to be injured and have permanent brain damage it would alter the way our brain communicates and receives information.

Studies have shown that chronic pain can alter our brain structure and function (Apkarian et al., 2004; Chronic Pain Harms The Brain, n.d.). When the human body is in constant pain the neurons will continuously fire messages to the brain and may not stop until this pain decreases, “when neurons fire too much they may change their connections with other neurons and or even die because they can’t sustain high activity for so long… this continuous dysfunction in the equilibrium of the brain can change the wiring forever and could hurt the brain” (Chronic Pain Harms The Brain, n.d.). A study that was published in 2017 shows the strong correlation between pain and depression due to the “perspectives of both brain regions and the neurological function system, whereby chronic pain may lead to depression” (Sheng et al., 2017). Chronic pain leading to depression is likely the effect of neuroplasticity changes on the occurrence and development of both chronic pain and depression (Sheng et al., 2017).

Chronic pain can impair memory as well as altering the brain’s wiring. According to a recent study “two-thirds of participants with chronic pain showed significant disruption of attention and memory when tested” (Chronic Pain Can Impair Memory, n.d.). This is likely because pain disrupts the maintenance of memory trace required to retain and process information for storage in longer-term memory. Pain and memory are received and processed by the thalamus as well as the parietal lobe. The thalamus and hippocampus are highly important parts of the brain responsible for memory tasks. When a patient is depressed or shows depression-like or pain symptoms the hippocampus raises its cortisol levels which interact with the development of neurons in the brain. Studies have shown that “persistent pain was associated with accelerated memory decline and increased probability of dementia” (Whitlock et al., 2017). Based on these findings, it seems plausible that reduction in pain through chiropractic adjustment may have additional benefits, such as improved cognition. Pain and memory are received and processed by the thalamus as well as the parietal lobe. The thalamus and hippocampus are highly important parts of the brain responsible for memory tasks. When a patient is depressed or shows depression-like or pain symptoms the hippocampus raises its cortisol levels which interact with the development of neurons in the brain. Studies have shown that "persistent pain was associated with accelerated memory decline and increased probability of dementia" (Whitlock et al., 2017). This study will be used to measure whether the benefit of spinal alignment can extend beyond previously studied topics to include cognition and whether this improvement is mediated by pain.

Methods

Participants

Nineteen patients (age 20 - 79, 13 females) in an acute state participated after giving consent in accordance with a protocol approved by the University of Oregon's Institutional Review Board. Fifteen patients received an adjustment while four patients received an alternative therapy, each patient followed their specialized treatment plan rather than randomization. All patients were in an acute state as defined by Whole Body Health LLC, this meant that all patients were on a treatment plan of being seen minimum of once a week.

Protocol

Each session began with patients filling out a short questionnaire in which they reported their age and biological sex, as well as any pain the patient may have, where the pain is located, on a simple pain scale from 1 - 10 what is the intensity of the pain and being asked to report whether they have been diagnosed with depression. This provided base knowledge about if their memory may have been impaired by another source or reason, such as depression, chronic pain, or age. After completing the short questionnaire, each patient proceeded to go through a set of cognitive functions testing auditory working memory, fluid reasoning, and visuospatial (visual) working memory. Spinal adjustments and alternative therapies were received based on the treatment plan Dr. Gleaves, DC created before the patient knew about the study. After a spinal adjustment or alternative therapy based on need rather than randomization, and a brief restoration period, patients reported their current pain levels again and completed the same set of cognitive tests with a different version. Each cognitive test took about 5 minutes per task and was completed in a treatment room with only the participant and researcher. In total the cognitive function tests took a total of 15 -20 minutes before the adjustment or therapy and 15 -20 minutes after.

Cognitive Screening

Auditory Working Memory Each patient was read aloud a list of words from version “one” or version “two”, assigned at random. After reading the list it was asked for the patient to repeat back as many words as they could remember. The same list was read aloud again, and the process was repeated, it was asked for the patient to repeat as many words as they could remember including the words they answered previously. The same list was read aloud for a third time, the patient was asked to repeat as many words as they could remember including the first two sets they previously answered. Once the list had been read aloud a total of three times the patient moved on to do a 5 minute reasoning screening before coming back to the list remembrance. After the reasoning task the patient was read aloud a longer word list that included the previous list as well as some random simple words. The patient was asked to answer a simple “yes” or “no” if the word was in the first list. The amount of words they remembered from the first list and said “yes” to, was the recorded value for their file.

Reasoning The short in-between during the auditory memory screening included the reasoning task. The patient was given 5 minutes and was asked to solve the Raven’s Progressive Matrices (Figure 1), either version “one” or version “two”, assigned at random. It was explained to the patient that their goal should be correctness rather than quickness so as to leave them less stressed about the time constraint. The amount of puzzles answered correctly was the recorded value for their file.

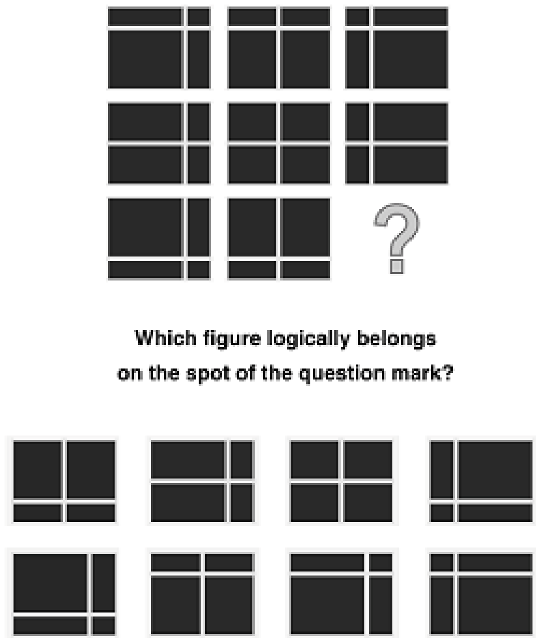

Figure 1: Example of the type of question that may be on the Raven's progressive matrices test.

Visual Working Memory After list remembrance and Raven's matrices the patients was asked to complete a visual memory game in which there was a grid/set of boxes on the computer. A couple squares were highlighted for a few seconds, and once they disappeared the patient needed to mark which of the boxes were highlighted. This was completed on a laptop and for the patients to mark the highlighted boxes they needed to click which box was highlighted on the screen. If needed patients were provided with a wireless mouse if the trackpad was too difficult or small. It was monitored and tracked in a data sheet which level each patient was able to make it to before they made their first mistake, the first mistake was marked as the last level they were able to make it to (Figure 2).

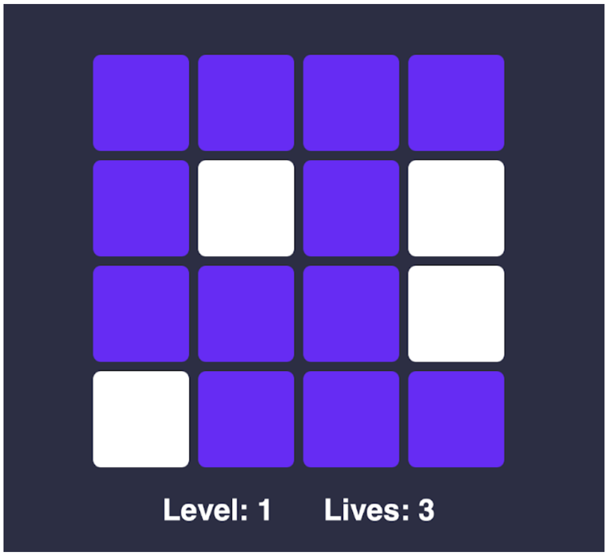

Figure 2: Example from level 1 visuospatial working memory game.

Treatment After all cognitive tests were completed Dr. Gleaves, DC performed a spinal adjustment, for those in the adjustment group. Oftentimes people will get dizzy/disoriented after an adjustment so to prevent this from interfering with results patients sat and waited for five minutes to let anything settle. This took a total of 10-12 minutes. For those who were in the therapy group they did a form of therapy under a licensed CA's supervision, this included either interferential current, ultrasound, or postural rehabilitation. Due to therapies taking 15 minutes there will be no recovery time. It was recorded which therapy was received and which portion(s) of the spine were adjusted according to their chart note. After the total allotted amount of time the patients were asked to rate their pain on a scale of 1 - 10, this was compared to their previous answer. Each patient then completed another version of the same cognitive tests using a different version.

Data Analysis

All data obtained, cognitive results and pain information, was then placed into a master excel spreadsheet with all patient identifiers removed. Each patient will then have their own row in which their unique identification number (i.e. 101071504, 100080292, etc), biological sex, age, which group they were a part of, and all of the results from their cognitive tests. It was anticipated that an equal number of patients across the different treatment types will be recruited. Due to the small sample size and treatment being dictated by medical needs of the patient rather than the by the experimenter, it was not possible to recruit an equivalent number of treatment types.

To evaluate the effect of treatment on pain and cognition, we utilized a repeated measures ANOVA with timepoint (pre, post) as a within-subject factor and treatment type (adjustment, therapy) as a between-subjects factor. Of main interest was the main effect of timepoint, reflecting changes in self-reported pain or cognitive test scores after treatment, and the interaction between timepoint and treatment type, evaluating whether the effects differ based on treatment type. I hypothesized that the adjustment group would have a positive linear slope because of the effect spinal manipulation has on the nervous system by improving transmission, while the therapy group would be flatter with little to no change.

Results

Pain

All data obtained from this study will be kept and analyzed using comparative tests. The simplest question is will the treatment have any effect on pain? This can be answered by comparing pre-to-post changes in the adjustment group to the pre-to-post changes in the therapy group. As well as simply comparing pre-to-post changes in both groups. Running "repeated measures ANOVA", pre-to-post can be compared as well as pre-to-post including treatment comparison can be tested. Repeated measures ANOVA with timepoint and treatment group showed a main effect of timepoint, no main effect of treatment group and no interaction (Table 1, Figure 3). Pain significantly decreased afterwards regardless of treatment given, going from an estimated average of 3.27 down to 1.86 on the pain scale. The lack of interaction indicated that pain improvement was comparable between treatment groups (interaction p = 0.85).

The effect of treatment on self-reported pain

	Sum of Squares	df	Mean Square	F	p
Timepoint	12.6754	1	12.6754	10.6851	0.005
Timepoint ✻ Treatment	0.0439	1	0.0439	0.0370	0.850
Treatment	4.74	1	4.74	1.07	0.316

Table 1. Pre-Pain vs. Post-Pain; The results of a 2x2 ANOVA with treatment and timepoints as predictor variables and pain ratings as the outcome variable. Pain ratings decreased from pre- to post-treatment, irrespective of treatment group.

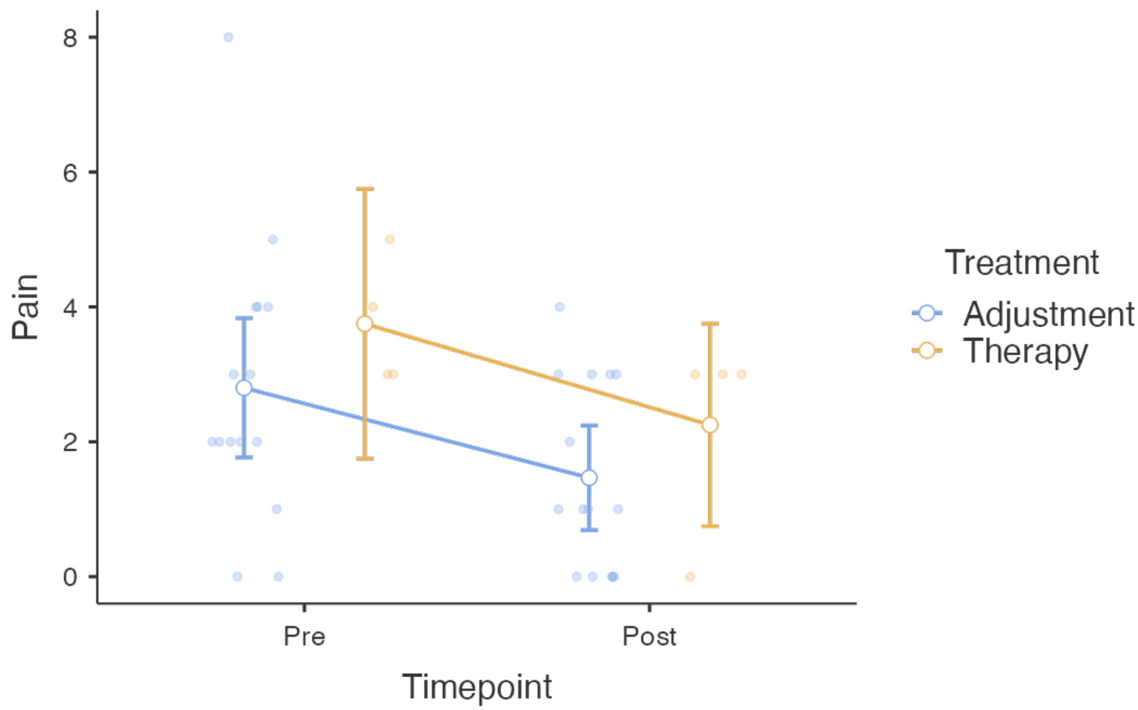

Figure 3. Self reported pain rating prior to treatment and following treatment, separately for each treatment group.

Visual working memory

The primary question is will the treatment have any effect on cognition? This can be answered by comparing pre-to-post changes in the adjustment group to the pre-to-post changes in the therapy group. As well as simply comparing pre-to-post changes in both groups. The results of visual working memory test are presented in Figure 4, Table 2. Repeated measures ANOVA showed no effect of timepoint, no effect of treatment group, and no interaction. In analyzing the data it can be seen that there was an increase in visual working memory and patients tended to perform better after treatment although those results are non-significant.

The effect of treatment on visual working memory					
	Sum of Squares	df	Mean Square	F	p
Timepoint	3.47	1	3.47	0.871	0.364
Timepoint ✻ Treatment	4.39e-4	1	4.39e-4	1.10e-4	0.992
Treatment	3.63	1	3.63	0.375	0.549

Table 2. Pre-Visual vs. Post-Visual; The results of a 2 x 2 ANOVA with treatment and timepoints as predictor variables and pain ratings as the outcome variable. No significant effects were found.

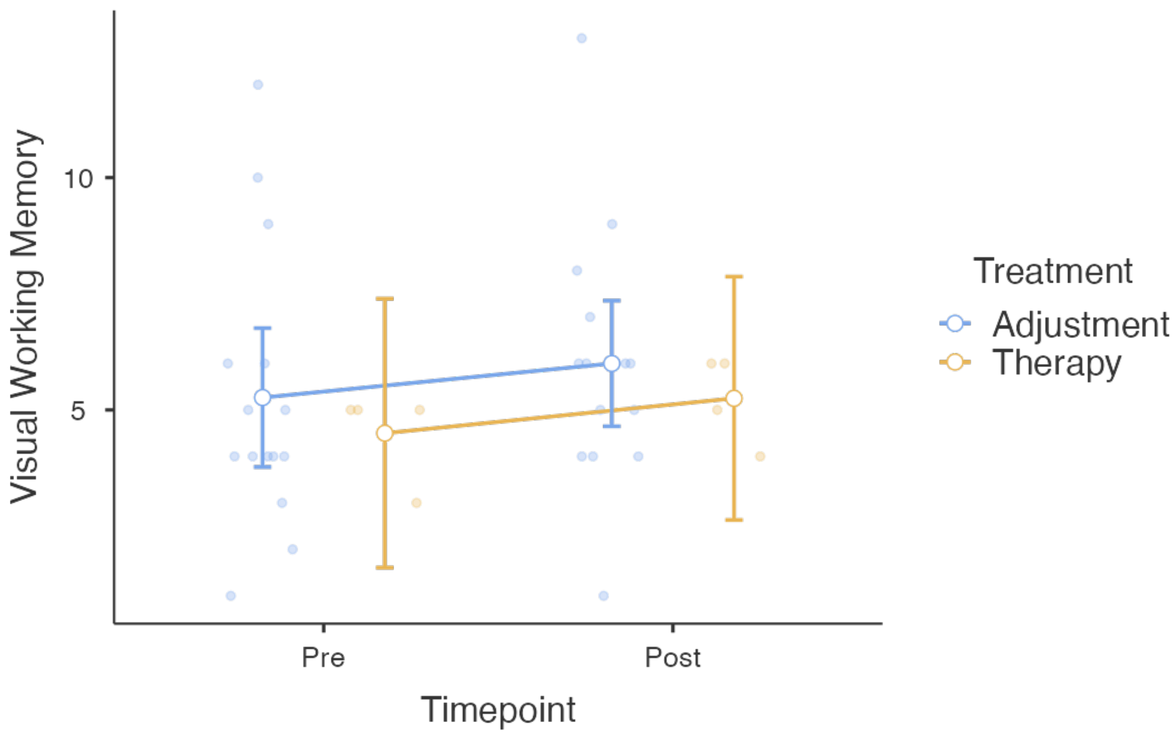

Figure 4. Visual working memory scores prior to and following treatment, separately for each group.

Auditory working memory

The results of the auditory working memory test are presented in Figure 5, Table 3. Repeated measures ANOVA showed no effect of timepoint, no effect of treatment group and no interaction.

The effect of treatment on auditory working memory					
	Sum of Squares	df	Mean Square	F	p
Timepoint	10.81	1	10.81	2.379	0.141
Timepoint ✻ Treatment	1.97	1	1.97	0.433	0.519
Treatment	1.63	1	1.63	0.161	0.694

Table 3. Pre-Auditory n vs. Post-Auditory; The results of a 2 x 2 ANOVA with treatment and timepoints as predictor variables and pain ratings as the outcome variable. No significant effects were found.

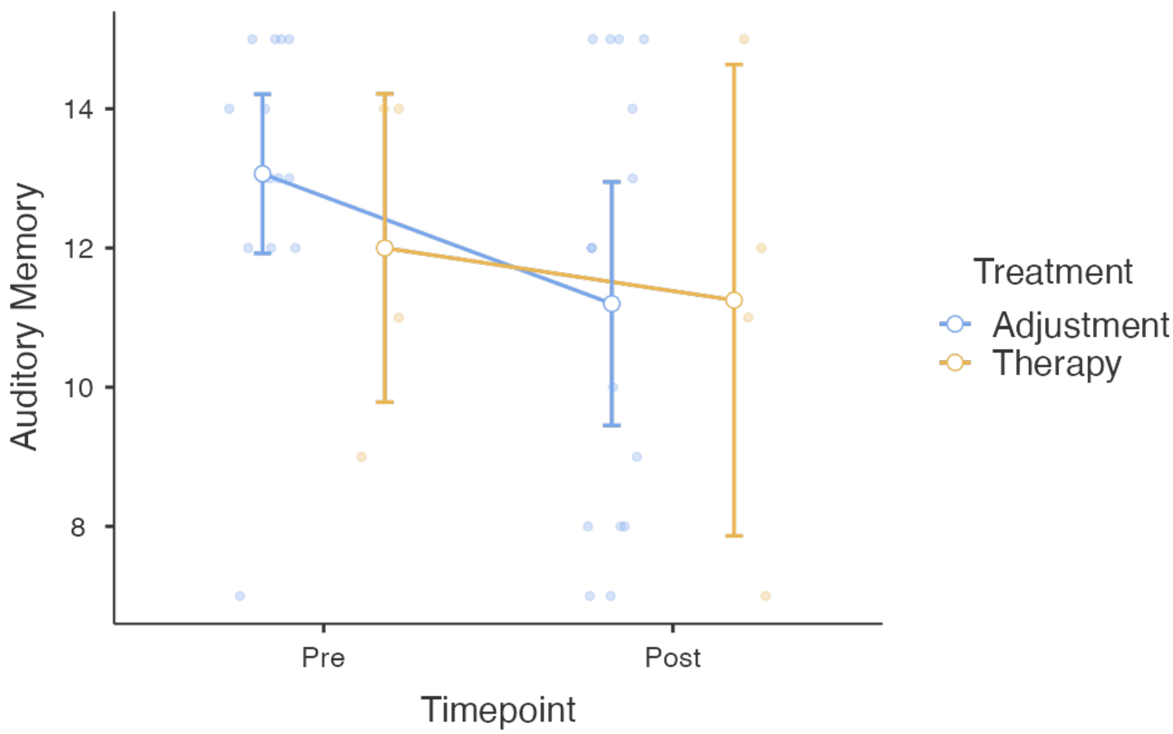

Figure 5. Auditory working memory scores prior to and following treatment, separately for each group.

Reasoning / Problem solving

The results of reasoning / problem solving are presented in Figure 6, Table 4. Repeated measures ANOVA showed no effect of timepoint, no effect of treatment group and no interaction.

The effect of treatment on reasoning / problem solving					
	Sum of Squares	df	Mean Square	F	p
Timepoint	7.30	1	7.30	1.933	0.182
Timepoint ✻ Treatment	2.88	1	2.88	0.762	0.395
Treatment	5.02	1	5.02	0.533	0.475

Table 4. Pre-Raven scores vs. Post-Raven scores; The results of a 2 x 2 ANOVA with treatment and timepoints as predictor variables and pain ratings as the outcome variable. No significant effects were found.

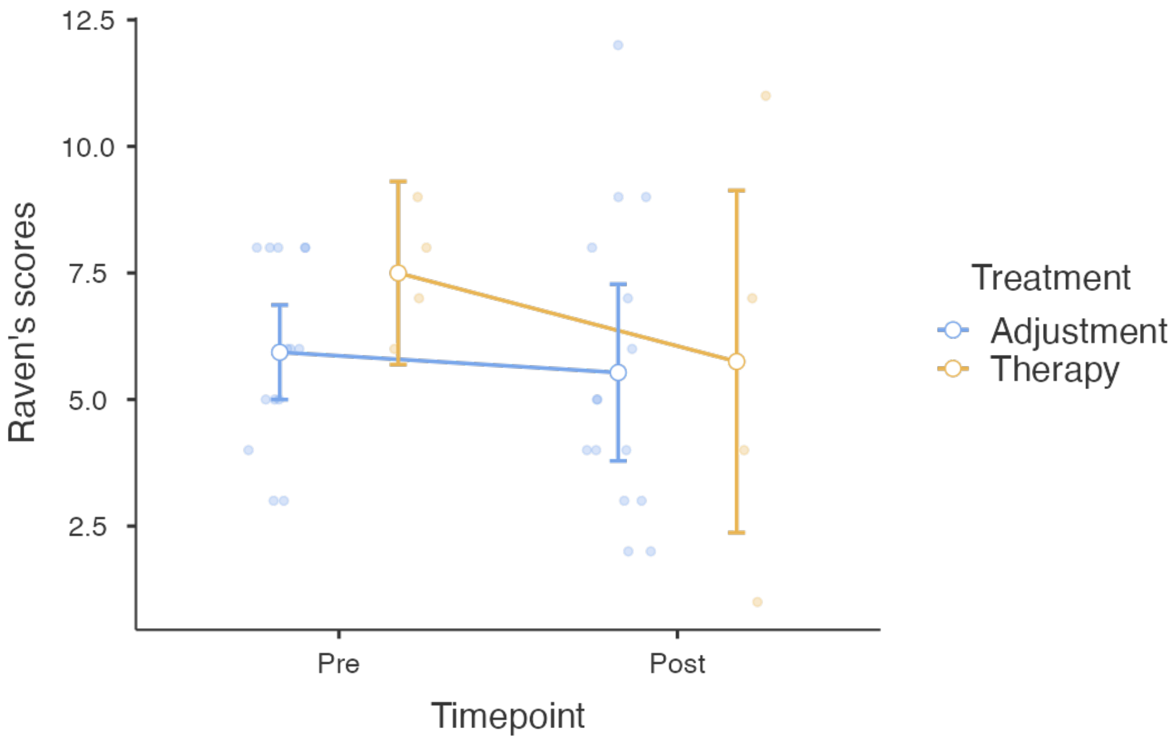

Figure 6: Raven's matrices scores prior to and following treatment, separately for each group.

Discussion

In this study we were interested in understanding whether chiropractic affects cognition. We tested a group of patients who received a spinal adjustment and compared their cognitive results to a group who received a therapy such as postural rehabilitation, interferential current, or ultrasound. This small sample size participated by testing their auditory memory, visual memory, and problem-solving skills before and after the treatment provided. There was a significant decrease in pain after treatment, regardless of the treatment given, but results showed no improvement in cognition.

As suspected pain decreased regardless of treatment type. This was expected and correlated to other studies done before this one, these treatments are specifically designed to decrease pain for patients in an acute state which is what they did. However raw pain results may have been overestimated. Patients may have wanted to please the researcher or be a “good” participant and provide the researcher with the best possible results.

After analyzing cognitive function before and after treatment it can be seen that results were not significant in showing any change in cognition including; auditory working memory, visual working memory, and reasoning. Numerically auditory memory got worse regardless of treatment type likely due to practice effects and interference. But again this proved to be non-significant because of the sample size and p-value.

Visual working memory typically improved after treatment, regardless of treatment type, but due to the sample size we worked with the results were insignificant. These results could have had been because of the repeated exposure. After understanding how the game works people typically perform better after getting a grasp on how it works.

Reasoning did not change regardless of treatment type. Post treatment looks to have gotten worse for the therapy group but due to the small sample size this cannot be proven. These results were very unexpected as people typically get better after exposure to the Raven's matrices because they develop a better understanding of how it works.

A way to combat these difficulties would be to add a third group in which they receive no treatment at all and compare the three groups rather than only therapy vs. adjustment. Another future experiment could include a pre vs post treatment plan rather than looking at only one visit. Dr. Gleaves DC has created an entire treatment plan prior to the patient participating in the study or not so each treatment plan is solely prescribed to each patient which again provides the beauty of each person being their own control.

Conclusion

Chiropractic has shown to have no effect on cognitive function, but neither has any type of other treatment given. It did however coincide with previous studies showing that chiropractic as well as other treatments given at the clinic decrease pain levels. This study has provided a basis for future research going forward since there has been limited research done on chiropractic. A plausible future experiment change might be to test cognitive function before, directly after, the next day, 5 days after the initial treatment, and 2 weeks after the initial treatment or the most likely effective experiment would be to test pre and post treatment plan.

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