Examining the Association between Cannabis Use and Working Memory, Processing Speed and Sub-Psychotic Subjective Experiences

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Abstract

New Zealand has among the top two highest prevalence of cannabis use in the world. Additionally, the strains of cannabis on offer in the market of New Zealand is among the most potent ones available. With these two factors at play within New Zealand society, it is important to know the effects of cannabis on mental health. Studies have suggested that regular/heavy use of cannabis can lead to psychosis, however other studies have presented findings contrary to this. Studies consistently found that individuals with psychosis performed much poorer on working memory measure via the digit-symbol subset of the *WAIS*. Thus this study aimed to investigate how cannabis use may relate with performance on digit-symbol task and sub-clinical psychotic experiences.

Method: A quantitative design was used to investigate relationships: between cannabis use, digit-symbol performance, and ratings of the *Sub-Psychotic Subjective Experiences Scale* (*SPSES*). Fifty one convenience sample participants (*n*=51) were included in the results of the study. 69% were aged 18-24 years, 84% of the sample population were students, and majority Europeans. Males and females were equally represented. The research sessions were conducted in an office-type laboratory environment. The first part entailed participants completing *Wechsler Abbreviated Scale of Intelligence 2nd edition* (*WASI-II*), and *Wechsler Adult Intelligence Scale 3rd edition* (*WAIS-III*) digit-symbol subtest with the researcher on a desk. Participants then moved to the computer to complete the questionnaires on background and history, cannabis use (*Cannabis Use Problem Identification Test (CUPIT)* and *Cannabis Abuse Screening Test* (*CAST*)

questionnaires for cannabis users), and the *Sub-Psychotic Subjective Experiences* **(***SPSES)* questionnaire.

Results: Participants were apportioned into four cannabis use groups using self-rating measures obtained from CUPIT and CAST scores. The user groups were 1: non-users, 2: previous users, 3: non-regular users, and 4: regular users.

An overall one-way (4 cannabis use groups) MANOVA conducted on the outcome variables digit-symbol scores, and SPSES scores, with depression scores and IQ scores as covariates) revealed no significant main effects, significant interactions or any significant covariates. Subsequent Spearman's Rank-Order coefficient, however, indicated significant correlations of cannabis use with *CUPIT* scores, *CAST* scores, and use of other recreational drugs. Pearson's correlation coefficient was used for correlation analyses for all other ratio and interval variables. There were no significant Pearson's correlations found.

Conclusion: The study found no significant association between regular cannabis use and digit-symbol performance; nor was there a significant association between cannabis use and sub-psychotic subjective experiences ratings. Therefore, the student-majority sample did not present any significant deficits in cognitive function depending on cannabis use. Cannabis use, and absence thereof, was also not related to IQ scores or depression reports.

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Introduction

New Zealand is ranking among the top two countries in the world with the highest cannabis use. The cannabis used in New Zealand has a stronger potency than traditional cannabis; in fact some of the strongest strains are grown and used here (United Nations Office on Drugs and Crime, 2012).

There exists a debate in the literature about the occurrence of psychosis as a result of heavy cannabis use. This debate has been ongoing for decades, and though both ends of the argument present convincing evidence supporting their claims, there seems to be no conclusive study which successfully explains the underlying activity. Though the current study does not aim to uncover the underlying activity, the findings may be useful to further support either claim.

Some literature suggests that heavy cannabis use may lead to the occurrence of psychosis (Andreasson, Allebeck, Engstrom, & Rydberg, 1987; Myles, Myles, & Large, 2016) , whereas some literature suggests that cannabis use is in fact helpful in the treatment of psychosis (Ferraro et al., 2013; Murray & Di Forti, 2016). On the other hand, some literature asserts that cannabis use under certain specified conditions is more likely to lead to psychosis; whilst claiming that use beyond the scope of these conditions should not lead to psychosis. Though the cause and effect relationship between cannabis use and occurrence of psychosis is unclear, there is a consistency in the correlation between cannabis use and first episode psychosis within the literature (Myles et al., 2016).

Furthermore, there is a consistent correlation within the literature between psychosis and performance on the *Wechsler Adult Intelligence Scale (WAIS)* digit-symbol subtest, revealing patients with psychosis (particularly schizophrenia) performing worse than the control groups in the varying studies. The digit-symbol test is usually used to measure working memory and processing speed. Hence inferior performance on this measure would imply impairment in the individual's working memory and/or processing speed (Dickinson, Ramsey, & Gold, 2007).

Patients with psychosis have been affirmed in numerous literature to have inferior working memory competences compared to their 'healthy' controls. These studies along with other relevant literature illuminating the topic of debate will be further outlined in the subsequent review of literature section.

The aims of this study were: 1) to identify whether regular cannabis users in a general population may exhibit higher ratings of underlying sub-psychotic experiences which may go undetected; 2) to assess whether cannabis use had an effect on working memory and processing speed using the digit-symbol subtest from the *Wechsler Adult Intelligence Scale (WAIS)*; and 3) to evaluate the relationships between these three variables to detect any significant associations if any.

With an existing relationship established in the literature between psychosis and performance on the digit-symbol test, this study aims to investigate how cannabis use would correlate with digit-symbol performance. There was only one study found which reported on this relationship (Jockers-Scherübl et al., 2007). These researchers used paired samples of a control 'healthy' group compared with a group of patients diagnosed with schizophrenia. This

entailed selected sampling with researcher manipulation over the study sample.

The current study of this report used a convenience sample in the university environment to demonstrate a more natural representation of a general population. This study will also be focusing on measures of different variables compared to the one study that was found.

The association between cannabis use and psychosis in the literature has not been very consistent, and for the current study it will be relevant to measure how cannabis use from a general population impacts subjective experiences.

This topic will be relevant to the literature as it gives fresh insight on something that has been marginally explored, within a different setting and under different dynamics. This should help fill a gap in the literature on the impact of cannabis use on performance in digit-symbol scale in particular.

Literature Review

1. Cannabis Use

For centuries, humans have used cannabis for fibre, seed, seed oils, medical treatment, and recreationally (Davis, 2016). Di Marzo (2014) asserts that it is used in at least four fundamental dimensions of human life: religion, health, manufacture, and recreation. Medical Marijuana is used for the treatment of chronic pain, muscle spasms, anorexia, nausea, and sleep disturbances. In the 1830's, Irish physician William O'Shaughnessy is alleged to have introduced the use of cannabis in a therapeutic setting in the western society (Di Marzo, 2014). The "explosion" of marijuana abuse arose in the 1960's within the western world (Di Marzo, 2014).

1.1. Prevalence

The most widely used illicit drug among the global adult population (15-64 years of age) is cannabis; with a worldwide prevalence ranging between about 2.6-5.0 per cent annually (UNODC, 2012). The highest prevalence of cannabis use in 2010 was reported in Oceania (primarily in New Zealand and Australia) ranging between 9.1-14.6 per cent (UNODC, 2012). The prevalence of cannabis use is much higher in New Zealand than the worldwide average. In New Zealand, approximately 42 per cent of all adults (15+ years) have tried using cannabis (Woodbridge, 2015). This was reported by the Ministry of Health (Manatu Hauora) in their New Zealand Health Survey in which they found that 11% of the participant adults reported using cannabis within the last 12 months. One out of every seven male participants in the survey had reported cannabis use within the last 12 months. Of all the participants who reported cannabis use, one third (1 out of 3) reported using cannabis at least weekly. These statistics are

comparable to those of the United Nations in their report asserting that the international drug problem trends mostly among young males living in urban areas (UNODC, 2012). People who were unemployed and also people from disadvantaged backgrounds were reported to be more likely to use illicit drugs (UNODC, 2012). In New Zealand, adults living in the most deprived regions and Māori adults were more likely to report cannabis use in the last twelve months in the national Health survey (Woodbridge, 2015).

1.2. Types of cannabis and potency

The Cannabis herb is called *Marijuana* whilst the resin of Cannabis is called *Hashish*. Marijuana is the flower bud of the plant, and it contains the highest concentration of the psychoactive substance –Tetrahydrocannabinol (THC) within the plant. When the resin glands of the plant are compressed it is referred to as *Hashish*. In New Zealand, most seizure cases were predominantly caused by cannabis herb (Marijuana) as opposed to Hashish (UNODC, 2012). Traditionally, Hashish has been known to have far greater levels of THC than Marijuana, thus was considered more problematic than Marijuana. The THC content of hashish was traditionally between 2-10 per cent, and that of Marijuana traditionally 0.5-9 per cent. Only about 0.5 of cannabis products were in the liquid form, and these would contain a higher potency. Cannabis oil contained about 10-30 per cent THC content, and Hashish oil about 40 per cent, and these both emerged in the 70's (UNODC, 2012). Though these liquid forms of cannabis are rarely used, the high potency of the THC content in them is noteworthy when looking into the impacts of cannabis use.

There are notable increases over the past two decades in the cultivation of higher THC-content cannabis varieties in most countries in Oceania and

other regions (UNODC, 2012). These variations of the drug are achieved through plant breeding and/or hydroponic farming. This means that New Zealand is ranking among the top two countries with the highest cannabis use, and the cannabis used has a stronger potency than traditional cannabis, in fact some of the strongest strains are grown and used here. The United Nations Office on Drugs and Crime (UNODC, 2012) also stated that augmented indoor production of cannabis is usually related to an increase in the potency of cannabis produced. The analyses of THC levels of samples confiscated in the United States indicated that THC content had more than doubled since the 1980's, and the UNODC asserted that this entailed that in western countries, Marijuana is no longer 'less problematic' than Hashish. They also suggested that the local production of this high-potency cannabis in large markets lead to imported cannabis becoming less significant within the market.

1.3. Synthetic cannabis

In New Zealand there have been increasing reports of synthetic cannabis available in the market, which would highly impact the dynamic of cannabis use (Satherly, 2017; Strongman, 2017). These strains of cannabis are made of different chemical compounds, and would result in different neurochemical activity. It is also worthy to note that synthetic cannabis has been found to be the cause of some deaths, whereas there are no reports of death resulting from natural cannabis (Satherly, 2017). New Zealand police have issued warnings about the synthetic strains of cannabis which are lethal. These strains of cannabis lack the natural controlling agents which moderate the effect of THC, thus resulting in unusually higher potency. The potency can reach up to fifty times the effect of natural THC, with the

average synthetic marijuana ranging between five to ten times THC potency (Satherly, 2017). Satherly (2017) stated that synthetic cannabis products were currently one of the easiest drugs to find on the streets. The New Zealand Herald reported that people seem to be able to distinguish the difference between the natural cannabis and the synthetic strains (Strongman, 2017). The synthetic cannabis was reported to be cheaper and have a distinctive smell unlike that of natural cannabis, and usually called by a different name “inert” (Strongman, 2017). This type of variant string of cannabis would possibly influence the validity, outcome, and confounding factors of this present study. The main reason for this would be that inauthentic strains would react differently on a neurochemical level than natural cannabis (Satherly, 2017).

2. Implications of Cannabis Use

The UNODC assert that cannabis use can cause serious impairment to one’s driving, and chronic use of cannabis can result in drug dependency, and behavioural and psychological problems, such as internalizing disorder (e.g., anxiety and depression). In New Zealand, 8 per cent of cannabis users participating in the national survey reported mental health harms, on account of their use of cannabis within the past 12 months. This is a relatively small percentage reported to call for serious attention on mental health issues arising from cannabis use on the basis of the ministry’s survey. However, this is not to rule out that regular/heavy cannabis users may experience mental health problems that they have not associated with their cannabis use, or are unable to identify, or are not reported.

3. Effects of Cannabis

In a clinical experiment conducted by J. J. Moreau the 1840s in which participants (including himself) were administered hashish, the participants experienced “occurrences of delirium or of actual madness”. On the other hand, modern day users had varying reports on their experiences (Di Marzo, 2014). Modern day clinical research on cannabis is conducted with precise doses of active compounds, whereas prior to the mid-1960’s the chemical basis of cannabis used in the research was not well established.

3.1. Defining psychosis

The New Zealand Early Intervention in Psychosis Society (NZEIPS) Inc. describes psychosis as a range of unusual experiences that can affect a person’s thoughts, feelings and experiences. The experiences can result in the person having difficulty in separating reality from non-reality. The New Zealand Mental Health Commission (MHC (1999)) explain that psychosis is a syndrome that features in a number of mental health disorders. This syndrome is recognized as a primary disturbance in perception (hallucinations), disturbed beliefs and interpretations of environment (delusions) and incoherent speech patterns (thought disorder). A ‘psychotic episode’ is when a person experiences this to the extent that it disrupts their ability to concentrate and maintain life responsibilities (Turner, Nightingale, Smith-Hamel, & Mulder, 2004).

The Mental Health Commission (1999) identify three stages of early psychosis in their booklet:

1) Prodrome

Non-specific changes in behaviour and mental state usually occur prior to the onset of the disorder. They may occur a few days or to an extended number of years prior to the onset with the following key features of this prodromal state:

a. Sleep disturbances
b. Appetite disturbance
c. Notable unusual behaviour
d. Blunted feelings or feelings incongruent to others
e. Incoherent speech (difficult to follow)
f. Notable preoccupation with unusual ideas
g. Ideas of reference- things having special meaning
h. Persistent feelings of unreality
i. Changes in the way things appear, sound, or smell

2) Acute phase

Symptoms of hallucinations, delusions, and/or thought disorder fully develop, often in combination with other psychiatric symptoms (e.g., anxiety, depression). Other conditions may be present with the psychosis.

3) Recovery phase

Symptoms of the acute phase are reduced/ absent, usually following treatment of the acute phase. Following the psychotic episode, people may experience some difficulty returning to ‘normal’ and making sense of their experience.

When investigating the subjective experiences of psychosis, McCarthy-Jones, Marriott, Knowles, Rowse, and Thompson (2013) compiled a meta-

synthesis of qualitative studies investigating the experience and highlighted four central themes:

1. Losing- loss of consensual reality, loss of self, loss of hope and motivation, loss of security in body and world, loss of relationships and pain caused
2. Identifying a need for, and seeking help
3. Rebuilding and reforging- reality and self, hope and fighting back, security in body and world, relationships and recovering through them
4. Better than new: gifts from Psychosis- reconnection with increased compassion for others, increased sense of creativity, individuals finding a sense of benefit from their experiences and giving back to others in similar situations.

Fergusson, Poulton, Smith, and Boden (2006) stated that psychosis is measured using either diagnostic criteria for psychotic conditions, or using scales which rank the level of psychotic symptoms from severe to none.

3.2. Cannabis and psychosis

Over the past three decades, confounding evidence is continuously presented regarding the association between cannabis use and occurrence of Psychosis. In 1987, Andreasson et al. revealed a positive correlation between the onset of schizophrenia (a common psychotic disorder) and cannabis use through a 15 year follow-up study of 45 570 Swedish participants (Andreasson et al., 1987). Myles et al. (2016) research indicated that cannabis use is prevalent with first episode psychosis (FEP)

and schizophrenia, and their research did not illuminate a clear reason behind this association. Their meta-analysis along with the findings from the Dunedin longitudinal study (Fergusson et al., 2006) suggest that persistent cannabis use from early adolescence is strongly correlated with the development of psychosis and lower IQ later in adulthood. Murray and Di Forti (2016) affirmed four other studies which further evidenced Andreasson et al. (1987) notion of a strong correlation between cannabis use and the occurrence of schizophrenia.

Previous research from the 90's has suggested that cannabis use could induce Psychosis, and literature from the early 90's discusses "Cannabis Psychosis" (Ghodse, 1986; Hall, 1998; Imade & Ebie, 1991; McGuire et al., 1994). Meanwhile, research from the early 2000's to date has suggested that cannabis use closely correlates with schizotypy and schizophrenia (Barkus, Stirling, Hopkins, & Lewis, 2006; Degenhardt & Hall, 2002; Forti & Murray, 2005; Jockers-Scherübl et al., 2007; Murray & Di Forti, 2016). This indicates that research has shifted from a psychosis caused by cannabis use, to cannabis use not being a cause of psychosis, although psychosis occurring as a by-product. Though the evidence may be confounding and has evolved over the decades, the assumption that cannabis use is strongly correlated with psychotic experiences still stands. According to the DSM-5 (p482) Cannabis is associated with psychotic disorders.

Andreasson et al. (1987) are mentioned as the first researchers to suggest that cannabis use may cause schizophrenia. They conducted a study in which they aimed to evaluate the role of cannabis as a causal factor, with the consideration of some confounding factors. They acquired information about their study population regarding drug habits, psychiatric history and

social background from a national survey in Sweden. Andreasson et al. (1987) mention a Swiss study by Ruppen et al. (1973) in which these researchers found that heavy cannabis users reported higher estimates of their cannabis use in anonymous questionnaires as opposed to questionnaires that were not anonymous (such as the national survey used by Andreasson et al. (1987)). This suggests that it is likely that the estimations of cannabis use in their study were lower than actual consumptions levels. Above this proposed misestimating of cannabis use within the study cohort, the researchers were not able to ascertain whether the relationship was that of a cause as opposed to effect. Though they proclaim a statistical association, it is not distinct whether the cannabis use is the cause of the development of schizophrenia, or whether the development of schizophrenia caused the use of cannabis.

Andreasson et al. (1987) conclude that cannabis use can only be considered a small indicator to the aetiology of schizophrenia. Only a minority of the schizophrenia cases in their study were cannabis users, with only 21 of them being heavy users out of 274 schizophrenia cases. To further support how discrepant this association is, Murray and Di Forti (2016) asserted that although there was a steep incline in the use of cannabis entering the latter part of the 20th century, there was no corresponding drastic incline in the onset of schizophrenia.

3.3. Cognitive effects of cannabis use

The “explosion” of marijuana abuse in the 1960’s brought up major efforts to identify chemical properties underlying the psychotropic activity. Di Marzo (2014) asserts that several of the first studies investigating the underlying mechanism of cannabis were prompted to corroborate the harmfulness of

cannabis as opposed to its medicinal properties. He alleges that this potential bias has influenced cannabinoid research, to an extent, for many decades. Di Marzo (2014) operated a laboratory, involved in cannabis and endogenous cannabinoids research, for 50 years. Hence, for at least five decades he was a professional in this realm, and would have been well acquainted with works specializing in the topic. Institute of Medicine, Benson, and Watson (1999) also allege that in controversial topics, scientific information is commonly misinterpreted, misrepresented, and over interpreted. According to them this includes the medical marijuana debate.

3.4. Chemical properties

Cannabis contains above 400 chemicals, and over 113 cannabinoids in Cannabis are unknown (Baggott, Coyle, Erowid, Erowid, & Robertson, 2011). “Cannabinoid” is the description of the chemical constituents of the cannabis plant believed to have a common molecular structure. This structure is thought to be characteristic of the cannabis plant, or a derivative of it (Kalant, 2014). The most potent and studied psychoactive chemical in Cannabis is Tetrahydrocannabinol (THC).

The endogenous (internal) cannabinoid system (ECS) modulates neuroactivity by playing important roles in the development of the central nervous system, synaptic plasticity, and response to internal (endogenous) and environmental insults (Lu & Mackie, 2016). This system is made up of cannabinoid receptors, endogenous cannabinoids, and enzymes responsible for the degradation and synthesis of endogenous cannabinoids. Disruptions of the Endocannabinoid System play a role in several psychiatric disorders such as schizophrenia.

On the other hand, the psychoactive chemical of cannabis, THC, is an exogenous (external) cannabinoid which produces biological effects through its interactions with the cannabinoid receptors. Di Marzo (2014) isolated numerous cannabinoids in cannabis over 50 years and found that no other cannabinoids showed the activity resembling that of from THC, thus bringing him and his team to conclude that there were no other major active compounds other than THC in the Hashish they sampled. Although over the years dozens of new cannabinoids have been found in various cannabis strain, with none presenting 'marijuana-like' activity, and most of them being minor constituents.

Outdated as their research may be, it is of relevance to note that Andreasson et al. (1987) reported Cannabis to have properties that are anticholinergic (inhibiting the action of Acetylcholine). Acetylcholine is primarily responsible for the stimulation of muscles; and also plays a major role with sensory neurons in scheduling REM (dream) sleep. Inhibition of this chemical would impair muscle stimulation, and regular sleep patterns. These researchers asserted that THC has strong negative effects on memory, cognition, and other functions of the central nervous system.

Dickinson et al. (2007) aimed to further specify, and measure the magnitude of impairment of schizophrenia patients on the coding task in comparison to impairments on other traditional neuropsychological instruments. They conducted a meta-analysis of 40 articles that investigated the performance of schizophrenia patients on coding tasks and other cognitive measures which represented a minimum of two other domains of cognition. They were able to conclude that the digit-symbol task exposed an inefficiency in processing information, a central feature of schizophrenia cognitive deficit.

These findings coincide with those of Mohamed, Paulsen, O'Leary, Arndt, and Andreasen (1999), Leeson et al. (2008) and Pantelis et al. (1997).

Contrary to all these findings, Ferraro et al. (2013) cited three meta-analyses in their article which indicated that patients with psychosis using cannabis presented superior performance than patients with psychosis not using cannabis. Jockers-Scherübl et al. (2007) compared 39 patients with schizophrenia against 39 “healthy” controls on cognitive function with the effect of chronic cannabis use after 28 and more days of abstinence. Within the Schizophrenia group were 19 cannabis abusers and 20 non-abusers. The ‘healthy’ control comprised of 18 cannabis-abusers and 21 non-abusers. As supported by the findings in the previously mentioned studies, they found that the schizophrenia group performed poorer on the neuropsychological tests compared to the control group. They found that regular cannabis use deteriorated test performance in healthy controls, however regular users among the schizophrenia group improved cognition on some tests. They summarised that cannabis abuse had different effect on the patients with schizophrenia than the control group based on their cognitive function (Jockers-Scherübl et al., 2007).

Jockers-Scherübl et al. (2007) found a statistically significant interaction between chronic cannabis use and the diagnostic group in their performance on the digit-symbol substitution test. Chronic abuse in the ‘healthy’ controls reduced their performance on the digit-symbol test. Conversely, chronic cannabis use within the schizophrenia group seemed to significantly improve digit-symbol performance. This interaction was not so significantly present in the other applied cognitive tests they used.

However, patients with schizophrenia abusing cannabis generally still performed worse than cannabis abusing controls on most of the tests.

4. Digit-Symbol Task and Psychosis

Pantelis et al. (1997) assessed spatial working memory and planning abilities in 36 hospitalized patients with chronic Schizophrenia using a computerized Neuropsychological Test Automated Battery (CANTAB). They compared their performance with a control 'normal' group, and other patients with other neurological disorders. They found that the chronic Schizophrenia group displayed the most impairment in their performance in visuospatial memory span than any of the other groups. This group were least skilful in developing systematic strategy to complete the task, thus indicating that they relied on a limited visuospatial memory span. Pantelis et al. (1997) found that this group's higher planning level on the CANTAB "Tower of London" task was lower too, as they made fewer perfect solutions and more moves to achieve completion of the task, and significantly slower movement than the other groups.

The researchers deduced that the slowness indicated sensorimotor impairment. They concluded that the 'initial thinking (planning)' stages of the Schizophrenia group was not impaired, and their lowered performance compared to other groups resulted from significantly prolonged 'subsequent thinking (execution)' delays.

Manoach (2003) cited 5 different neuroimaging studies that evidenced prefrontal cortex dysfunction in schizophrenia during working memory performance. The neuroimaging revealed 'task-related hypofrontality' in the schizophrenia patients. They demonstrated relative physiological hypo

activity in the prefrontal cortex during performance compared with the 'healthy subjects'. These findings of hypofrontality during working memory activation have been consistent even with widely varied methods, patient's status and tasks used for activation.

Leeson et al. (2008) found that patients with recent-onset psychosis performed significantly worse on the digit-symbol processing speed subtest along with other measures of verbal and working memory. This affirmed the finding of Manoach (2003) regarding hypofrontality during working memory activation in schizophrenia patients. In their study Leeson et al. (2008) paired 53 psychosis patients with 53 controls to compare their performance on all scales of measure include in the Wechsler Adult Intelligence Scale (WAIS). They aimed to distinguish whether poorer performance of the psychosis group was a generalized deficit, or whether there were underlying specific abnormalities. The two groups were matched according to age, sex, and current full-scale IQ scores. On all subtests, except the digit-symbol test, the groups presented similar patterns of performance. Performance results on this subtest accentuated a specific deficit within the psychosis group compared to their matched 'healthy' controls.

The findings of Leeson et al. (2008) were further corroborated by the findings of Mohamed et al. (1999). Their study confirmed an inferior performance of schizophrenia patients on the digit-symbol test and comprehension subscale. Furthermore, the results of their study suggested that the impairment was characteristic of Schizophrenia. This was revealed through the fact that regardless of patient treatment, institutionalization, and

varying levels of chronic illness of the patients with schizophrenia, they consistently appeared to perform lower on these measures.

5. Effect of Depression on Cognitive Function

During the search for relevant literature, numerous articles came up on the impact of depression and bipolar on digit-symbol performance and cognitive function in general. These disorders were found to have an overlap in symptomatology presenting psychomotor deficiency (van Hoof, Jogems-Kosterman, Sabbe, Zitman, & Hulstijn, 1998). Depression groups were found to perform poorer than their controls on the digit-symbol test (Hart, Kwentus, Wade, & Hamer, 1987; van Hoof et al., 1998).

For this reason, depression was included within the measures as a likely confounding factor. This factor was projected to possibly impact the results in an unprecedented way.

Purpose of this study

The primary aim of this study was to explore relationships between cannabis use, subjective experiences, and performance on the digit-symbol subtest. The hypothesis supported by findings in the literature was that regular cannabis use would likely result in some occurrence of psychosis, at least on a sub-clinical level. The assumption was that regular cannabis use would also result in inferior performance on the digit-symbol task, indicating impaired working memory and processing speed. Therefore the hypothesis of the study was that regular cannabis use would result in a positive relationship with sub-psychotic subjective experiences (perception) ratings, and a negative relationship with digit symbol performance. Measurements of psychotic experiences was intentionally on a sub-clinical

level. Though the above literature mostly outlined findings including patients with schizophrenia, this study aimed to investigate the presence of sub-clinical experiences of schizophrenia in regular cannabis users within a generalized setting.

The next section outlines the methodology of this study along with the research process, and a plan of the statistical analyses further conducted for the results.

Method

This was a quantitative study primarily investigating one outcome variable (digit-symbol performance) and two predictor variables (cannabis use, and sub-psychotic subjective experiences). An investigation of the effect of cannabis use on sub-psychotic experiences was also a primary component of investigation.

Two measures were used for cannabis use: one was measuring extent of cannabis use in participants having used cannabis (CUPIT scores); and the other categorizing cannabis use, categorising cannabis use in to four groups. Using IBM SPSS, Sub-psychotic subjective experiences scale (SPSES) scores were analysed as ordinal variables, digit-symbol scores as scale measures, CUPIT scores were taken as scale measures, and cannabis use was a nominal measure. Participants were only tested once and on a voluntary basis.

1. Participants

A non-selected sample of individuals were collected primarily through the university. Posters (see *Appendix A*), 'word-of-mouth', and social media advertising was used to gather participants for the study. Posters were placed around the Psychology department, and distributed via the psychology students' mailing list. Participants within the Psychology department at the university were offered 1% course credit for any of the eligible course offering credit for research participation. As a result, majority of the participants were tertiary level students and from the University of Waikato where the study was conducted.

One pilot was tested in order to trial and redefine the procedure, and provide feedback and suggestions on the experience, and measure how long the process would take.

A total of 52 participants (excluding the pilot) (*n*=52) were recruited for the study with an equal distribution between males (*n*=26) and females (*n*=26). Majority (*n*=36) of the participants fell into the age range of 18-24 years, and majority of them (*n*=44) were students. *Table 1* below outlines demographics of the sample population.

Table 1.

Participant Demographic information summary

Demographic	%
Age:	
18-24	69.23
25-34	23.08
35-44	1.92
45-54	5.77
Ethnicity:	
European	59.62
Māori	19.23
Pacific	7.69
Asian	1.92
Indian	1.92
African	15.39
Other	5.77
Occupation:	
Student	84.62
Employed part-time	32.69
Employed full-time	9.62
Self-employed	7.69
Unemployed	1.92
Other	3.85

2. Materials

The first questionnaire collecting background information and demographics of the participant was devised by the researcher after finding relevant items in the literature found to negatively impact digit-symbol performance (e.g., mental health conditions, and use of other drugs). The questions were devised to take potential confounds into account, and gather information ordinarily used for demographics to outline a profile of the sample population.

The Wechsler Abbreviated Scale of Intelligence second edition (*WASI-II*; Wechsler (2011)) was used to assess cognitive ability by producing an intelligence quotient (IQ). The main purpose of testing for IQ, was to eliminate further confounds in the research. It is an abbreviated version of the *Wechsler Adult Scale of Intelligence (WAIS)*. This test was designed to quickly and accurately estimate cognitive intelligence when the full battery (the *WAIS*) is not feasible or necessary (McCrimmon & Smith, 2012). The *WASI* has been evidenced to be appropriate for clinical and research use (McCrimmon & Smith, 2012). In this case it was neither necessary nor feasible to administer the full battery, because only an estimate of cognitive ability was needed. This was to ensure that cognitive ability would not be the reason for poor scores.

The scale offers two options for administration, one consisting of two subtests (FSIQ-2), and the other using all four subtests of the scale (FSIQ-4). The FSIQ-2 was sued for this study. The two subtests administered were the Vocabulary and Matrix Reasoning tests, and these were sufficient to

estimate the participant's Full Scale IQ range using a 95% confidence interval (McCrimmon & Smith, 2012; Wechsler, 2011).

The digit-symbol substitution test was obtained from the third edition of the *Wechsler Adult Scale of Intelligence* (*WASI-III*). This subtest is a neuropsychological test often used to measure processing speed, working memory, and visuo-spatial skills (Bettcher, Libon, Kaplan, Swenson, & Penney, 2011). This test is done on paper using a pencil, and the participant is timed by the administrator. The participant is required to correctly fill in a series of symbols matching the number assigned to the symbol. They are presented with a template (see *Appendix J*) in which they have to fill in the empty boxes with matching symbols for the number above the empty box. The participant is given 90 seconds to fill in as many boxes as the can. This test is required to be administered in a quiet place, with minimal distraction, and on a table (Bettcher et al., 2011).

The rest of the measures were completed electronically by the participant on their own with the researcher present for any further assistance or queries. These included cannabis use screening items, and a scale rating sub-psychotic experiences.

The *Cannabis Use Problems Identification Test (CUPIT)* (see *Appendix F*) is a self-reporting screening scale comprised of 16 questions to detect current and potentially problematic use of cannabis (Bashford et al., 2010). This assessment battery includes a number of established measures of cannabis-related pathology from DSM-IV/ ICD-10 diagnostic criterion for cannabis use disorder. Bashford et al. (2010) found the *CUPIT* to be a reliable and valid battery appropriate for use within varying diverse

communities and for all ages. The *CUPIT* is readily available and can be self-administered by any individual wanting to use it.

The *Cannabis Abuse Screening Test (CAST)* (see *Appendix* G) consists of six questions aimed at identifying patterns of cannabis use leading to negative consequences in an individual's life on a social and/or health level (Legleye, Piontek, & Kraus, 2011a). (Legleye, Piontek, & Kraus, 2011b) confirmed that the *CAST* is appropriate for use in both clinical and research settings. They asserted that it is a useful scale to estimate Cannabis Use Disorder (CUD) prevalence.

In order to measure subjective experiences with sub-psychotic elements, as highlighted in the section 'Defining Psychosis' from the literature review, a questionnaire was required to obtain a quantitative measure. There was no single scale obtainable that measures sub-clinical psychosis on its own. The literature suggested that psychosis could be detected in an interview. However, the purpose of measuring psychosis in the study was not diagnostic, it was merely to asses and compare subjective cognitive experiences between the groups. This measurement was used to examine the implicit notion that cannabis users would rank higher on the experiences scale compared to non-users. This was used to further investigate the presence of sub-clinical psychosis in regular cannabis users.

The Sub-Psychotic Subjective Experiences Scale (SPSES) was used to assess how individuals would rank subjective experiences linked closely with psychosis in terms of frequency and intensity of experiences. Chiappelli et al. (n.d.) developed the *SPSES* which is made up of 21 five-point Likert scale items. The scale evaluates subjective cognitive experiences and was

developed after reviewing several interview-based rating measures on basic symptoms. Majority of the items are based on the 'Cognitive Disturbance' risk criteria from the "Schizophrenia Proneness Instrument, Adult version (SPI-A)"(Schultze-Lutter, Addington, & Rurhmann, 2007) ordinarily used in the field of medicine (psychiatry). The other items in the scale were adopted from other schizotypal personality assessment tools. It is a "self-rating under clinical interview environment" format. This entails that it should be administered in the presence of the interviewer, however, to be completed by the participant on their own.

2.1. Scoring

2.1.1. *WASI-II* and Digit-Symbol

The *WASI-II* IQ scale, and *WAIS-III* digit-symbol test both came with a physical manual including instruction on how to score performance and interpret the score. The *WASI-II* scores were a result of the 2-test version of the *WASI-II*. Only the Matrix Reasoning and Vocabulary Tests were used to measure IQ.

The Raw score for the digit-symbol test is the total number of correct symbols matched in the corresponding boxes. Raw scores were converted to standardized scaled scores (according to age ranges) using the relevant designated table for this conversion in the *WAIS-II* manual included in the battery.

2.1.2 *CUPIT*

The *CUPIT* came with an attached document as shown in *Appendix F* which highlighted the scoring procedure. Question 2 was used to screen for most recent cannabis use (past 3 months) and question 1 screening cannabis

use in the past year. A cumulative score of 12 or higher was considered an indicator of cannabis-induced problems (Bashford et al., 2010).

2.1.3. CAST

The *CAST* has a maximum score of 6, as each question is scored either 1 point or 0, and the sum of points from each question gives us the score for this test. A score of two cautions the user to be careful of their cannabis use, and a score of 3 or higher indicated problematic use of cannabis. This measure was used mostly to affirm *CUPIT* scores, and the scores were not used in further statistical analyses.

2.1.4. SPSES

The *SPSES* rating sub-psychotic experiences did not include scoring information in the manual, and the information was not made readily available. Therefore an overall sum of scores for each question was used as would be done with any other ordinary Likert-scale questionnaire. Scoring on the Likert scale had the following ratings for the experiences: 0-Never happens; 1-Happens, Less than once a month; 2- Several times a month; 3- Several times a week; 4- Happens almost every day.

3. Procedure

Participants expressing interest in participating in the research scheduled a booking with the researcher to come in for the research session (see *Appendix A*). The sessions were approximately 35-45 minutes long. This was all done within the controlled environment of one of the laboratories in the Applied Cognitive Psychology laboratories. The room was ‘office-type’ with a computer for the electronic components of the study,

and separate desk with two chairs, on opposite sides, for the *WASI-II* administration.

The session started with the researcher briefly explaining the research and giving the participant an information sheet (see *Appendix B*) to read before starting the session. Following this, the participant was then required to sign two consent forms (see *Appendix C*), one to give back to the researcher and the other for the participant to keep. Once they had signed the consent forms, the next step was the completing the two subtests of the *WASI-II* required to determine the FSIQ-2. Then the participant proceeded to do the digit-symbol Coding test. Once they were done with this, Google's "generate a random number" was used to generate two 3-diggited numbers. The two numbers were separated by a forward slash to become the participant's number for the next section of the research. The number was also written on the scoring sheets for the *WASI-II* and the digit-symbol tests.

The participant then proceeded to complete the online portion consisting of a series of questionnaires. The questionnaires included the demographics information and some background history (see *Appendix D*), screening for cannabis use (see *Appendices E and G*), and the sub-psychosis scale (see *Appendix I*). Only those who reported cannabis use were presented with the *CUPIT* and *CAST* questionnaires.

Whilst the participant completed these questionnaires on the computer, the researcher was scoring their *WASI-II* and digit-Symbol performance to obtain raw scores. This was done within the room, on the desk used for the *WASI-II* test, back towards the participant's back to reassure the participant that their responses were completely anonymous. At the end of each day

that participants came in, their raw scores were converted into scaled scores (for the digit-Symbol test) and final Full Scale IQ 2-test (FSIQ-2) for their performance on the *WASI-II*. This was also done within the same laboratory, to avoid any materials being misplaced (i.e., the tests and the transcripts).

4. Statistical Analysis

The three outcome variables of the study were *WAIS-II* IQ scores, performance on the digit-symbol test, and overall scores on the *Sub-Psychotic Subjective Experiences Scale (SPSES)*. All analyses were done using *IBM SPSS Statistics Version 23*. Initially the *SPSES* was analysed for validity and reliability on the basis that no further psychometric information was available on the scale. Internal validity was done using a Pearson's correlation for each of the 21 items in the scale. There was no significant correlation between Question item 18 and the overall *SPSES* scores (r=.22, n=52, p=*.118*). This item was removed from the scale, consequently disqualified from the total score.

The *SPSES* was assessed for reliability as a scale, and found to be reliable (good Cronbach's Alpha value, α=.89); robust (wide range of scores indicating varying aspects of psychosis were measured: range=2-58); and sensitive (good test to detect positives because there was a wide variance in the total scores, *SD*=14.25).

Following this, cannabis use was ranked into four groups using *CUPIT* scores for "Question 1" measuring cannabis use in the past 12 months. This was used to identify any outliers in the scores of the groups using *IBM SPSS* Boxplots. The groups were: 1-'Non-user' group with participants that had

never used cannabis (*n*= 15); 2-'Previous user' group with participants that had not used cannabis for 12 months and longer (*n*= 9); 3- 'Non-regular' user group with participants scoring 5 and below on "Question 1" (*n*= 13); and 4-'Regular' were participants ranking 6 and above for "Question 1" (*n*= 15). Score of 5 and below indicated cannabis use averaging an estimate of 2 days a week or less. Scores from 6 upwards indicated cannabis use estimates of 3-4 days a week or more.

One non-regular cannabis user used other recreational drugs more frequently than cannabis use, thus this case was removed from the analyses in the results. Other recreational drug users used the other drugs less than once a month, and these cases were retained because their other drug use was marginal.

The digit-symbol boxplot indicated a single outlier for the digit-symbol performance score; a 'non-regular user' with a scaled score of 15. FSIQ-2 boxplot revealed three outliers. A non-user with the FSIQ-2 estimate of 140, regular cannabis user with a FSIQ-2 estimate of 144, and a previous cannabis user with the estimate FSIQ-2 of 88. *SPSES* boxplot reflected two outliers from the four groups, one regular user with the overall SPSES score of 79 (the highest score), and a previous user with an overall of 54.

Contrastingly, when the data were categorised into two groups: 'users' (*n*= 29) and 'non-users' (*n*= 23) only two outliers were revealed from all the boxplots. These outliers were the FSIQ-2 scores of 140, and 144, and no other outliers emerged.

Once the outliers of the data were revealed, the next step was plotting scatter plots and distribution graphs to evaluate the distribution of the

different variables being assessed. This was to affirm linearity, normal distributions, along with other necessary assumptions relevant for further analysis of the data. The digit-symbol and FSIQ-2 data had normal distributions. The *SPSES* scores reflected a positive skew, which could be traced to the *SPSES* scores in the 'previous users' (*n*=9) group, and the 'regular users' (*n*=15) group. The most distinctive difference is reflected in the extremely low scores of the 'previous' users group'. This group had the lowest range 25-38 (excluding the outlier score of 54). The other irregularity was in the 'regular users' group with the highest range from 26 to 79, with the 4th quartile ranging from 50 to 79.

Given that the sample population was gathered at convenience primarily from a pool of students, the data should closely represent what one would find in a similarly characterized sample. For this reason all outliers were included in further analyses, as the outliers were very unlikely to be an error. The extreme scores of the particular outlier cases may reflect other extreme scores on the other measures which could likely reveal some relationship.

The primary focus of the study is to identify relationships between variables, if any; thus all cases were considered important to avoid bias in the findings. Given the inclusion of outliers, the analyses reported in the remainder of this report were bootstrapped on IBM SPSS. The bootstrapping conditions were bias corrected accelerated (BCa) confidence intervals in simple bootstrap samples of 1000. The confidence intervals for all the analyses was 95%.

Two-tailed tests of significance were used for all correlations. Pearson's correlation coefficient was used for all ratio and interval variables, and Spearman's Rank-Order correlations were conducted for correlations

including nominal (categorical) variables. Correlations of cannabis use indicators along with correlations for main variables in the study were conducted.

Chi-square analysis was used to affirm the strength of the association between the cannabis use, and the use of other drugs.

A series of one-way analyses of variance (ANOVA) were conducted on *SPSES* scores, IQ scores, and digit-symbol scores within the four groups (i.e., the cannabis use groups as independent variable) to detect any significant differences in means.

A one-way (4 cannabis use groups) Multivariate Analysis of Covariance (MANCOVA) was conducted to determine the relationship of cannabis use on digit-symbol scores and *SPSES* scores with the recorded possible confound variables as the covariates. These included the use of other drugs, IQ, and depression. Pillai's Trace test statistic was used to interpret the output results of this analysis (Field, 2009)

All the results of the outlined analyses are detailed in the section to follow.

Results

The results of the study include a sample population of 51 (*n*=51) on account of the invalid case that was removed from the original gathered sample of 52. This results section will outline what was found regarding the relationships between the variables and taking into account possible confounding variables.

1. Descriptive summary of Results of Variables

1.1. *Sub-Psychotic Subjective Experiences Scale (SPSES)* Scores

Previous cannabis users had a mean score significantly lower than the means of the other groups and the overall mean for the sample population, along with the smallest variance in scores than the other groups (μ= 12.33, *SD*=8.82, s^2= 77.75). Regular cannabis users presented the highest mean and variance of scores within the group (μ= 22.53, *SD*=16.62, s^2= 276.27).

The differences in means between the four groups in this variable were not statistically significant. This was found in the results of the one-way analysis of variance (ANOVA) of cannabis use on *SPSES* scores (F (3, 47) = 1.23, p=.31).

1.2. *WASI-II* FSIQ-2 Scores

WASI-II IQ scores presented high variability, and the overall mean was comparable with the average IQ range within the general adult population of 70-110 (*M*= 109.55, *SD*=11.29, s^2= 127.53). Nine participants obtained IQ scores above 120 indicating superior performance on the scales, and 2 participants scored above 130, which is likely to indicate intellectual giftedness. The lowest IQ score was 88, which still falls into the average

range of the general population of 70-130 (Wechsler, 2011). Ergo, no underlying cases of learning disability or inappropriate level of understanding of the scale were revealed in the IQ results.

The group with the highest mean of IQ scores was the non-cannabis users with a high variance of scores within the group (μ= 111.87, *SD*=11.02, s^2= 121.55) and previous users obtained the lowest mean of IQ scores (μ= 106.22, *SD*=9.79, s^2= 95.94). Non regular users had the lowest variability in the scores within the group (μ= 111.67, *SD*= 8.59, s^2= 73.88), with regular users indicating the highest variance in scores within the group (μ= 107.53, *SD*=14.14, s^2= 199.98). *Table 2* outlines descriptive statistics within each group for measured variables.

The differences in overall IQ score means within the four groups were not statistically significant, as shown in the results of one-way analysis of variance (ANOVA) between IQ and cannabis use (F (3,47)= .760, p=.52).

When outliers were excluded, the regular users obtained lowest mean of IQ scores and still maintaining highest variance (μ= 104.93, *SD*=10.28, s^2= 105.76)

1.3. Digit-Symbol Coding Test Scores

The variability of overall scores for the digit-symbol was not as radical as the other two variables, although there was notable variance in the scores (*M*= 10.29, *SD*=2.27, s^2= 5.17). The means and variance of scores within each group were sufficiently analogous. The lowest group performance was that of the regular users (μ= 10.2, *SD*= 2.31, s^2= 5.31), and the highest scoring group were the non-regular cannabis users (μ= 10.42, *SD*=2.23, s^2= 4.99). *Table 2* summarises the details.

The differences in means between the four groups in this variable were not statistically significant, as shown in the results of one-way analysis of variance (ANOVA) between digit-symbol scores and cannabis use (F (3,47)= .02, p=.996).

Table 2.

Overall descriptive statistics for relevant variables

	n	Range	*M*	*SD*	s^2
SPSES	51	2-58	20.49	14.19	201.29
FSIQ-2	51	88-144	109.55	11.29	127.53
Digit-symbol	51	5-15	10.29	2.27	5.17
CUPIT	36	0-48	16.47	12.80	163.86
CAST	36	0-5	.67	1.04	1.09

Note: *SD= standard deviation;* s^2*= variance*

1.4. Cannabis use

All cannabis users reported having used primarily Marijuana, and 8 of the regular users also used other forms of cannabis (see *abis used* among cannabis users

Table **3**). There was one regular user that reported using Hashish, and 2 non-regular users reported using Hashish.

Cannabis Abuse Screening Test (CAST) and *Cannabis Use Problem Identification Test (CUPIT)* scores were used to corroborate self-reports of cannabis use.

Overall, there were 36 participants that had used cannabis at least once in their lifetime. Current cannabis users included 27 participants out of the sample of 51. There were 15 regular cannabis users, and 12 non-regular users. 15 participants of the sample population had never used cannabis in

their lifetime, and 9 out of the sample population had not used cannabis in over at least 12 months. *abis used* among cannabis users

Table **3** outlines types of cannabis used among cannabis users

Table 3.

Types of Cannabis used in the different groups

	Previous	Non-regular	Regular	Total
Marijuana	9	12	15	36
Hashish	2	2	1	5
Cannabis Oil	0	2	6	8
Other	0	0	1	1

Note: 'Other' not specified

1.4.1. Cannabis-use indicators

Cannabis use groups indicated a strong and positive relationship with *CUPIT* scores (r^s (34) =.831, p=.00). as *CUPIT* scores were higher, they indicated a higher ranking in cannabis use categories Cannabis use and *CAST* scores indicated a positive and moderate to strong relationship, as *CAST* scores were higher, they indicated a higher ranking in cannabis use categories (r^s (34) =.507, p=.002).

The verifying scores of the *CAST* on *CUPIT* scores showed a significant positive Pearson's correlation, thus indicating a strong positive relationship between *CAST* and *CUPIT* scores (r (34) =.792, p=.00). The higher the *CUPIT* score, the higher the *CAST* score would be, which validates the *CAST* as successfully corroborating cannabis use ranking and CUPIT scores. These correlations were measured to verify true reports on cannabis use, and are detailed in Table 4.

Table 4.

Bivariate correlations of cannabis use indicators

		n	Pearson's *r*	*p*	Spearman's r_s	*p*
Cannabis	CUPIT	36	-	-	.831	.00***
CUPIT	CAST	36	.792	.00***	-	-
CAST	Cannabis	36	-	-	.580	.00***

Note: 'Cannabis'= the cannabis use categories (i.e. Non-user, Previous user, Non-regular user, Regular user); *p< .05; **p< .01; ***p<.001

Overall, *CUPIT* scores of 12 or above indicated a possibility of Cannabis-induced problems (Bashford et al., 2010). The overall mean *CUPIT* score for cannabis users indicated an expected general cannabis-induced problems within the sample population (*M*= 16.47, *SD*=12.8*,* s^2= 163.86). Evidently the regular users had a higher mean, however, they also indicated more variability in scores (μ= 29.07 *SD*=8.28*,* s^2=68.49) compared to non-regular cannabis users (μ= 8.83, *SD*=5.39*,* s^2= 29.06). As could be expected, the mean for non-regular users was below 12 with a lower variability in scores. *Table 5.* Outlines the details of these statistics.

Table 5.

Descriptive statistics for variables in separate groups

	n	*μ*	*SD*	s^2
FSIQ-2	51	109.55	11.29	127.53
No	15	111.87	11.02	121.55
Previous	9	106.22	9.79	95.94
Non-regular	12	111.67	8.59	73.88
Regular	15	107.53	14.14	199.98
Digit-Symbol	51	10.29	2.27	5.17
No	15	10.27	2.43	5.92
Previous	9	10.33	2.4	5.75
Non-regular	12	10.42	2.23	4.99
Regular	15	10.2	2.31	5.31
SPSES	51	20.49	14.19	201.29
No	15	22.33	14.92	222.52
Previous	9	12.33	8.82	77.75
Non-regular	12	21.75	12.53	157.11
Regular	15	22.53	16.62	276.27
CUPIT	36	16.47	12.8	163.86
Non-regular	12	8.83	5.39	29.06
Regular	15	29.07	8.28	68.49

Figures 1 and 2 below illustrate the summary of results presented in *Table 4* above.

Figure 1.

Cannabis use on overall SPSES and digit-symbol scores

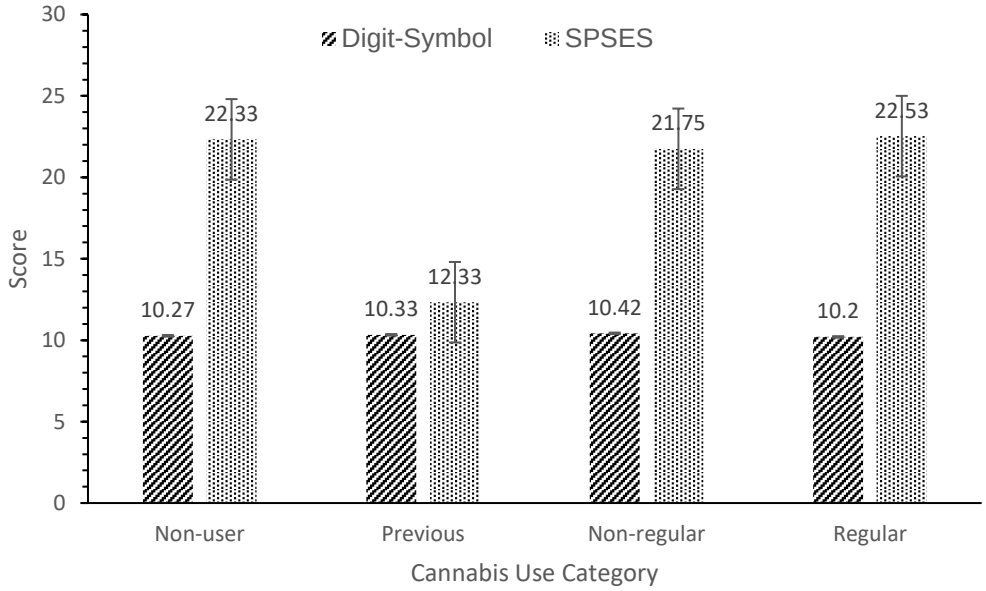
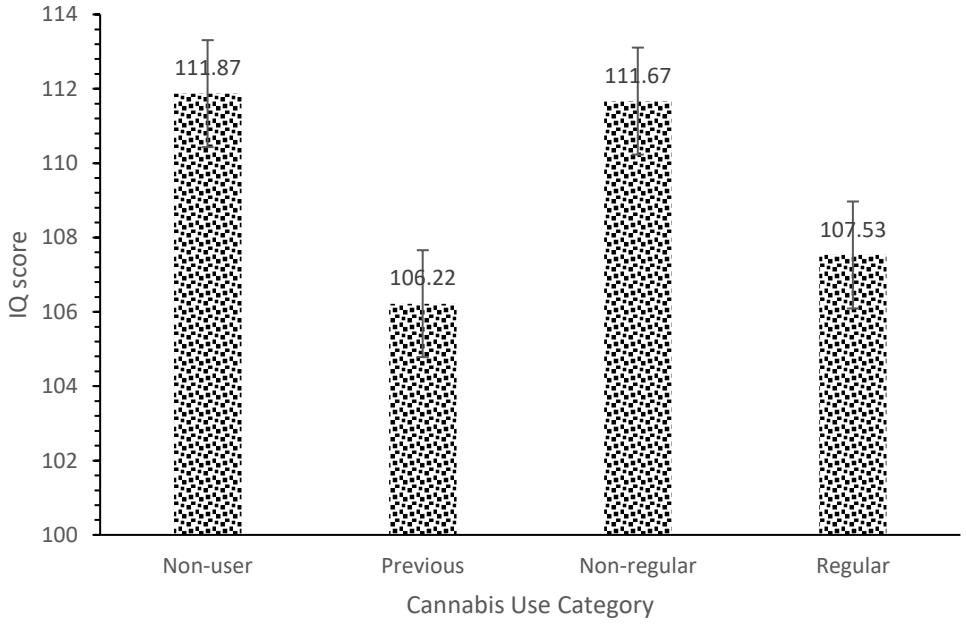


Figure 2.

Cannabis Use on overall IQ



1.1. Other Possible Confounds

Three possible confounds that were likely to influence digit-symbol performance were recorded and taken into account. The 3 variables were IQ scores, the use of other drugs, and depression and bipolar; conditions that the literature indicated should impact digit-symbol performance. Ten participants used other recreational drugs, and they were all current cannabis users too. Table 6. below summarises the details of mental health diagnoses and use of other recreational drugs within each comparative group.

Table 6.

Other possible confounding variables in study

	Non-user (*n*=15)	Previous user (*n*=9)	Non-regular (*n*=12)	Regular (*n*=15)	Total (*n*=51)
Depression	2	2	2	3	9
Other Drugs	0	0	4	6	10
Total	3	4	10	14	31

Note: ‘Other drugs’ not specified

2. Correlations

Spearman’s Rank-Order Correlations were used for correlations including ‘cannabis use, ‘depression’, ‘other drugs’, and ‘FSIQ’ (because of IQ outliers) variables. Pearson’s correlations were conducted for other correlations not including these variable.

Table 7 summarises the correlation results for each of the main variables in the study. No statistically significant relationships were found between any of the variables.

Table 7.
Bivariate correlations of main variables

		n	Pearson's *r*	*p*	Spearman's r^s	*p*
SPSES	Digit-Symbol	51	-.147	.305	-	-
Cannabis	Digit-Symbol	51	-	-	.004	.980
Cannabis	SPSES	51	-	-	.037	.794
CUPIT	Digit-Symbol	36	.044	.8	-	-
CUPIT	SPSES	36	.143	.406	-	-

Note: 'Cannabis'= the cannabis use groups (i.e. Non-users, Previous users, Non-regular users, Regular users).

2.1. Other Possible Confounds

There was a moderate and negative relationship between cannabis use, and the use of other drugs (r^s (49) = -.438, p= .001). Responses to 'Other Drug use' question were coded as follows: "1=yes" and "2=no". Thus, those in group 1 (yes) ranked higher in cannabis use, and those in group 2 (no) ranked lower in cannabis use. The Chi-square test affirms the statistically significant association between cannabis use and the use of other drugs (χ^2 (3) = 11.24, p= .01)

3. Multivariate Analysis of Covariance (MANCOVA)

An overall one-way (4 Cannabis use groups) MANCOVA was performed on digit-symbol scores and *SPSES* scores with the use of other drugs, IQ, and depression as covariates. Pillai's trace indicated no significant effect of cannabis use on digit-symbol performance and *SPSES* scores V= .09, F (6,

88) = .68, *p*= .66. None of the covariates indicated a significant effect over the variables in this analysis.

The next section is the discussion section which will discuss the results delineated in this section.

Discussion

The results showed no statistically significant evidence to support the hypotheses that: 1) regular cannabis users would have higher ratings of sub-clinical psychotic experiences; and 2) the use of cannabis would result in lower digit-symbol scores, thus regular users obtaining among the lowest scores in the sample population. The results showed no significant relationships were found between the three variables. Furthermore there were no statistically significant differences in means for each of the core variables of measure (digit-symbol performance, SPSES scores, and IQ scores) within the four groups (cannabis use). This indicated that cannabis use did not significantly influence the measures of IQ, *SPSES* scores, and digit-symbol performance. None of the expected confounds had a significant effect on the main variables of the study.

1. Cannabis Use

Twenty out of the 51 participants were current users of cannabis (52.94%), and the extent of their cannabis use was compared in two measures. This was to confirm the reports on one measure would correspond with the results of the other measure to affirm extent of cannabis use. *CAST* scores successfully correlated with *CUPIT* scores, thus confirming the extent of cannabis use within the sample population. The majority of these participants were students, and although the high *CUPIT* and *CAST* scores suggested problematic levels of use, it was interesting to find that the cannabis use did not impact their performances on the other measures in the study.

This study only accounted for typical strains of cannabis stemming from natural forms of cannabis. These were marijuana, cannabis oil, hashish, and

other types reported were edible (cooked into foods) forms of the natural strains. However, the recent reports in New Zealand media regarding increasing cases of synthetic strains of cannabis would likely impact the results of this study if any participants were either knowingly or unknowingly using synthetic strains. The reports in the media seemed to suggest that individuals using the drug were able to distinguish natural from synthetic. It is probable that participants would have reported the use in synthetic cannabis in the 'other' section asking about types of cannabis used, or in the section asking about the use of other recreational drugs. Participants only reported use of the aforementioned natural types of cannabis.

2. SPSES findings

The *SPSES* questions were used to assess sub-psychotic experiences that may exist undetected. This scale was to reveal whether regular users would indeed report higher ranking of sub-psychotic 'symptoms' than the other groups**.** This was indeed the case, with regular users obtaining the highest mean of 22.53; however the difference was not on a significant level as non-user ratings followed immediately with a mean of 22.33.

In order to avoid bias in self-ratings of the *SPSES*, words closely linked with/related to the word "psychosis/ psychotic" were avoided, and the word 'perception' used in replacement. The participants were told that this scale was to assess their subjective experiences on a day-today basis.

There was no chronological order of *SPSES* score in accordance with level of cannabis use. The results of the correlation analysis of *SPSES* overall scores and cannabis use indicated no relationship between the variables. Correspondingly, *SPSES* scores indicated no effect as a predictor variable

in the analyses of variance. These findings contradict the hypothesis of a positive relationship between cannabis use and *SPSES* scores. Accordingly, regular cannabis users did not present the significantly higher ratings of sub-psychotic experiences hypothesised.

Three of the four groups presented comparable distributions in their overall *SPSES* ratings, and respectively close results to the overall statistics of the sample population.

It is critical to note the particularly extremely low *SPSES* self-ratings of the 'Previous users' group. The group did comprise of the smallest number, and their scores all ranged below the mean except for the outlier. This particular group scored exceptionally low, and had the lowest variance in ratings; and this may have been on account of varying reasons.

This segment of the study (the *SPSES* questionnaire) raised the most queries among participants. Numerous participants seemed to find the questions either too lengthy or difficult to understand. This may have created the unexpected bias in their answers, consequently the rampant variance in scores. Comprehension of the questions may have been especially more difficult for the older population because of the choice of wording. The majority of the 'previous users' group comprised of the older participants of the study; this may have been an influencing factor on the ratings of the scale. The other aspect worth note is that the questions appeared in a very small text, were very lengthy, and presented as the last item of the session. This may possibly have made the questions more difficult to read along with participants eager to complete the session.

The feedback from participants after the sessions all seemed to suggest that the last measure was slightly more complex to comprehend and/or complete. The wording of questions (complexity) along with text size may have contributed to the extreme variance in participant ratings.

The ‘regular cannabis users’ presented scores with the highest variance than any other scores measured in the study. The fact that this scale is a self-report scale may have, to some degree, also resulted in some bias.

3. Depression

There should have been a relationship between depression and digit-symbol performance as indicated in varying literature. Participants with depression were anticipated to perform significantly poorer on both the digit-symbol test, and achieve lower IQ scores. This was the reason this item was measured as a confounding factor in the study, and included in the analysis of the results. There was no statistically significant effect of depression on any of the other variables. The sample size of those with depression was 9 out of the 51 sample population, thus a relatively small number. An element relevant to this is that the participants had been reporting a diagnosis of the disorder; therefore most likely receiving treatment for their depression. This may be the reason why no notable relationship was found between depression and any of the other variables of the study.

4. IQ

IQ was measured in this study because this item would most likely impact individual performance on the digit-symbol, along with prospect of comprehending the other measures. There were two very high IQ scores, possibly indicating intellectual giftedness. These two scores were included

in the results, because they were representative of a sample population with similar characteristics. All other IQ scores fell within the average IQ of the larger population ranging within 70-130. This was to be expected given that majority of the participants were tertiary level students. There were no statistically significant relationships between IQ scores and any of the other variables. This means that IQ had no significant correlation with scores on digit-symbol test, and SPSES.

Overall in the literature, IQ scores of patients with psychosis were inferior to those of the 'healthy' controls (Leeson et al., 2008; Mohamed et al., 1999). Patients with psychosis were found to perform poorer on the subtests relying more heavily on working and verbal memory (Leeson et al., 2008) and information processing (Dickinson et al., 2007). Thus it was expected that those ranking higher on the *SPSES* scale would most likely obtain lower IQ scores, and lower IQ would correlate with cannabis use (inferred from the hypothetical notion that cannabis use would correlate with SPSES). However, this was not the case, the group with the lowest IQ scores were previous cannabis users, and this group also scored the lowest ratings on the SPSES.

On the other hand, the next lowest IQ group mean was the 'regular cannabis user' group, and this mean was only 1 score higher than the 'previous user' group. This mean included the highest IQ score in the study, as the individual fell into this group. This entailed that the mean for this group was significantly more elevated than what it would have been without this outlier. With the exclusion of the outlier, the regular cannabis user group would have achieved the lowest IQ, and this would correlate with what is suggested in the literature. This group also had the highest mean for SPSES

ratings, consequently coinciding with what would be expected. Increase in SPSES scores was expected to result in decline in IQ scores. The ultimate implication is that the ‘regular cannabis user’ group would achieve the lowest IQ (without the outlier case) and the highest SPSES scores. This is only on a surface level inspection of results, analysis revealed no significant relationships. Ultimately, there was no significant effect of IQ on any of the other variables. Consequently, results revealed that IQ was not a significant confounding variable of the study, and did not disturb the results of the other measures. The exclusion of the outlier case would be a misrepresentation of the sample population, and would reduce the authenticity of the degree to which the sample population represents a similarly characterised population.

5. Digit-symbol

The hypothesis that there would be a negative correlation between cannabis use and digit-symbol performances was not confirmed by the results of this study. The proposed notion was that regular cannabis users would perform poorer on the digit-symbol. The statistics indicated a negligible relationship between cannabis use and digit-symbol performance. Both correlations between cannabis use on digit-symbol scores, and *CUPIT* scores on digit-symbol scores presented insignificant relationships. The *CUPIT* scores measured extent of cannabis use, and no correlation between *CUPIT* scores and digit-symbol performance indicated that the extent of cannabis use among users did not correlate with their performance on the digit-symbol test.

SPSES results were also compared with digit-symbol results to determine whether or not there would be a negative relationship. There was no

significant correlation between *SPSES* scores and digit-symbol performance. This suggests that experiences of psychosis do not produce a significant correlation with digit-symbol performance.

The digit-symbol test primarily measures working memory, processing speed and visuo-spatial memory. Psychosis is described as a range of unusual experiences that can affect a person's thoughts, feelings and experiences. Experiences of psychosis usually affect the cognitive domains measured by the digit-symbol test, thus there should have been a relationship present between SPSES ratings and individual's performances on the digit-symbol test. The absence of such a relationship brings to question whether the SPSES scale in fact measured experiences associated with underlying psychotic symptoms, or whether the scale was in fact a robust measure including all the features of psychosis. Although the measure is not a diagnostic tool, and only functioned to measure subjective experiences, if the subjective experiences were indeed associated with symptoms of psychosis then there should have been a statistically significant relationship between the variables. The questions of the SPSES though outlining some features of sub-psychotic experiences may have failed as a predictor tool of sub-psychotic experiences. Though the reliability and internal validity of the SPSES were tested and confirmed, perhaps the construct validity of the questions could be further investigated.

Co-occurrence of cannabis use and other recreational drugs. 10 out of 27 (37.03%) of current cannabis users were using other recreational drugs. This included 6 out of 15 regular users (40%), and 4 out of 12 non-regular users (33.33%). These are large portions of the cannabis users that were currently using other recreational drugs, some would be using multiple other

recreational drugs too. Although the frequency of use of other recreational drugs was low, this variable could have majorly influenced the results of the study. This is especially the case for the use of other drugs more potent than cannabis.

6. Limitations and further directions

6.1 Sample

Overall, though 51 participants were sufficient at this level for statistical significance within a 'clinical population' this number may not have been enough to bring about a sufficient representation of all the variables in the study. Predominantly important to note was that the variables were compared in groups of four, which further decreased the sample statistic in each group. The analyses looking at relationships within the four groups were done on relatively small numbers, and would make the findings less generalizable to the larger population. A larger sample population would be beneficial for future study similar to this one. Otherwise a smaller division of the already collected number (e.g., into three groups instead of four).

Paired Sampling may have been very useful to avoid the very radical results within the variables. For example if participants were matched according to IQ, age, and gender, then it would have reduced the number of major differences between individual samples. Although the participant sample of convenience was selected to provide a more adequate representation of what would be more likely to be found in a similarly characterized population. The random representations within the sample may have led to the drastic variability in results, however, this also provided a more authentic representation of what could be found in general without researcher manipulation.

6.2 Materials

A review of the chosen materials and measures of the study.

6.2.1 SPSES

It became apparent that the use of the SPSES to indicate underlying sub-clinical experiences could be improved in future studies. This measure proved to be somewhat wordy and not very user friendly for the participants (too complex). Another thing to consider is that although the test appeared to be testing the same thing and produced reliable scores, whether or not the scale was in fact measuring sub-psychotic experiences in a vigorous custom could not be confirmed. It seems the questions were primarily focused on issues pertaining to attention as opposed to an array of experiences involved in psychosis, even on a sub-clinical level. It might be useful to replace the use of the SPSES measure in future studies, however it may be difficult to find other similar measures which are not diagnostic. The primary reason for using the questions in this scale was to avoid diagnosis, and just to assess subjective perceptions of individuals. However, whether or not these experiences correlated with psychosis (one of the main factors of investigation in the study) was unconfirmed. A problem regarding the SPSES was that very little to no other information about the measure was available.

This is not to completely nullify the results of the SPSES results, because ultimately the scores were found to be reliable and valid, thus indicating a measure of some particular feature (perhaps attention). The scores on this scale did ultimately indicate problems in subjective perceptions; however,

the questionnaire items may not have fully covered all the features defining psychosis.

Given that obtaining better scales to measure sub-clinical psychotic experiences were a challenge, it might be worth looking into devising a scale for such a measure; one that is not diagnostic and practical for research purposes.

6.2.2. Cannabis Use

The use of the CUPIT and CAST score to corroborate self-ratings of cannabis use proved the most successful element in the study. The CUPIT was not only very useful in identifying frequency of cannabis use among users, it was also very useful in measuring extent of cannabis use. The CAST scores effectively estimated the extent of cannabis use too, thus producing a strong positive relationship between CUPIT and CAST scores.

An important factor that was neglected in the results of this study was age. The literature regularly mentioned the age at which an individual began using cannabis as an important predictor variable in terms of developing psychosis. Age was poorly recorded in this study, particularly the timeframe in which individuals had been using cannabis. The number of years, and starting age of cannabis use are important variables that were neglected in this study. These are important variables to factor into future research endeavours along the same stream as this study. Age and years of cannabis use are more likely to have been better predicator variables of psychosis than most of the other variables measured in this study.

6.2.3. IQ & Digit-Symbol

The decision to use the 2-test version of the WASI-II may have reflected more accurate IQ estimates with the inclusion of the other 2 subtests. This would have given more rigorous results, although IQ testing was not a primary goal in the study. However, after testing the first few participants it became apparent that there would have in fact been enough time to complete all four subtests of the WASI-II. This would have also allowed more results to compare in the analysis. The only reason the Matrix Reasoning and Vocabulary subtest results were not mentioned in the results of this study is because they yielded no statistically significant relationships. The inclusion of their analyses against the other variables would have been futile, given that the study was not focused on these measures. In a future study it might be possible that all subtest may be useful and there might be significant correlations between the subtests and other variables within the study.

The other thing is that radically inclined results on the IQ scale may have occurred on account of the fact that only two subtests were used to measure IQ. These tests may have presented the best or worse indices within the individual.

Only one part of the digit-symbol test was used, the coding part. This was because the literature tended towards deficiencies in the coding process of the digit-symbol test (primarily processing speed). It would be interesting to look into how individuals would perform on the incidental recall component of the test. This component measures how many of the symbols are remembered immediately after completing the coding task. This task is more focused on the working memory aspect of the digit-symbol scale.

Including this measurement in the study, the study might have had interesting results to look at and compare.

Conclusion

The primary objective of this study was to assess performance on digit-symbol performance alongside self- reports of cannabis use, and self-reports of sub-psychotic experiences (distorted perception) for any correlations.

Sub-psychotic experiences were measured to identify whether regular cannabis use would result in higher ratings, thus demonstrating undetected experiences of psychosis within the general population of cannabis users. No significant relationship was found, thus suggesting that regular cannabis users in the general population do not ordinarily experience sub-psychotic experiences that are undetected.

The assumption was that higher ratings of sub-psychotic experiences would result in lower scores on both full-scale IQ and digit-symbol performance, and vice versa. However, no significant relationships were found in this study to support these notions. There were no relationships found to support the notion that regular cannabis us would diminish digit-symbol performance indicating impairment in working memory and processing speed. This task, particularly the coding part of the test, was proven to be difficult among individuals with psychosis. The theory was that if regular cannabis users displayed symptoms of psychosis, they would correspondingly perform poorer in the digit-symbol test. This study did not produce results to support this notion, thus supporting the null hypothesis of the study.
All the measured variable that were expected to present strong influence (confounding variables) over the research variables did not present any significant relationships with the research variables. Thus no confounds were identified from the analysis.

A significant relationship was found between cannabis use and the use of other recreational drugs. Although the frequency of the other drugs all ranged below a frequency of once a month, the potency of the other drugs in comparison to cannabis varied. Past drug history was not accounted for either, only current use. An implication of this would be that lasting effects on cognition from these other drugs could have presented a bias in the results of the study. The use of other drugs did not, however, present a significant relationship with the other variables in the study. The measurement of other drug use was not very intricate, as this was not the focus of the study.

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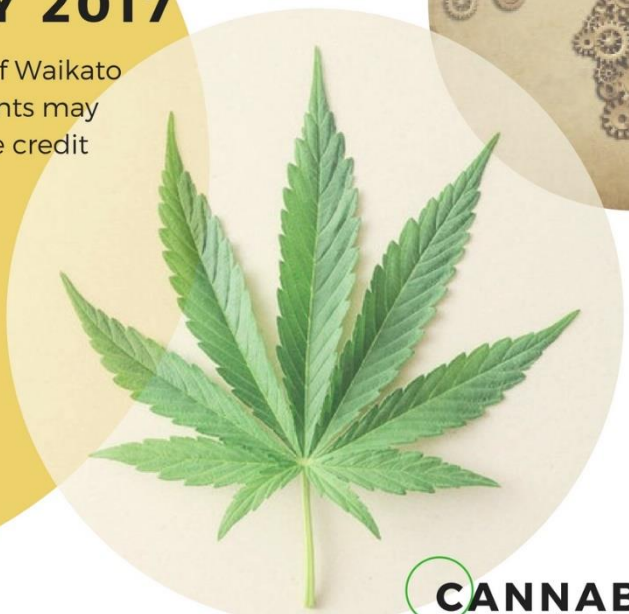
Appendices

Appendix A: Research Participant Recruitment Advertisement

PSYCHOLOGY RESEARCH PARTICIPANTS WANTED

MAY-JULY 2017

Eligible University of Waikato psychology students may receive 1% course credit



CANNABIS USE ON DIGIT-SYMBOL PERFORMANCE AND PERCEPTION

My research requires participants to complete three cognitive tests and an online questionnaire. I am investigating the effect of cannabis use on working memory and perception.

WHO: NON-CANNABIS users AND Cannabis users of all levels, 18+ years of age

WHERE: University of Waikato, Hamilton Campus

DURATION: Approx. 40-50minutes (contact me to make a booking)

ALL responses are CONFIDENTIAL and ANONYMOUS. Participants have the right to withdraw at any time

CONTACT DETAILS
EMAIL: psychcannabis@gmail.com
MOBILE: 0210590274
RESEARCHER: Wabuya Vaka
SUPERVISORS: Dr Robert Isler & Dr Rebecca Sargisson

This project has been approved by the School of Psychology Research and Ethics Committee

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Appendix B: Participant Information Sheet

Cannabis use on Digit-Symbol Performance and Perception

Participant Information Sheet

This study aims to investigate the relationships between cannabis use, cognitive experiences, and performance on the Digit Symbol Test. The Digit Symbol test is one of the tasks used in cognitive psychology for measuring processing speed, and working memory.

What is requested of the participant?

1) Read through and sign TWO consent forms
2) Approx. 25-30 mins for two cognitive tests: WASI Vocabulary subtest, and WASI Matrix Reasoning subtest. Both of these tests are verbal tests and no writing is required. You will be asked questions which you will respond to verbally whilst the researcher records them
3) Approx. 3-5 mins Digit-Symbol task. For this task, you are requested to match symbols with their corresponding digits within 120seconds. You will be required to write for this exercise and all materials (pencil and paper) will be supplied.
4) We will then move on to the computer for the second part of the session. We will generate a random participant number for you to quote on your questionnaire and to write on the tests we have just completed.
5) After this, you are requested to complete approx. 10-15 minute electronic questionnaire. This is completely anonymous, and you may request for the researcher to leave at this time.

The overall estimated time for the session should be approx. 40-50 mins.

Your participation is greatly appreciated. All information is confidential and anonymous and participants have the right to withdraw at any time.

Any further queries or information that you may require regarding the research, kindly contact the primary researcher (Wabuya Vaka) at psychcannabis@gmail.com. If you have any concerns regarding the research you are welcome to contact Wabuya or her supervisor Dr Robert Isler at robert.isler@waikato.ac.nz

If you feel unsettled because of the content of this study and require further support or professional help, you are kindly encouraged to call the free Waikato crisis line on 0800505050, which is in operation 24/7. Alternatively, if you are a student at the university you may reach the student counselling service at counselling@waikato.ac.nz or on +64 838 4037

The Research protocols for this research have been reviewed and approved by the School of Psychology Research and Ethics Committee

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Appendix C: Participant Consent Form

CONSENT FORM

A completed copy of this form should be retained by both the researcher and the participant.

Research Project: Cannabis Use on Digit Symbol Test and Perception _

Please complete the following checklist. Tick (✓) the appropriate box for each point.	YES	NO
1. I have read the Participant Information Sheet (or it has been read to me) and I understand it.		
2. I have been given sufficient time to consider whether or not to participate in this study		
3. I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet		
4. I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without penalty		
5. I have the right to decline to participate in any part of the research activity during or before the session		
6. I know who to contact if I have any questions about the study in general.		
7. Due to the sensitive nature of this research I may feel unsettled, and I know who to contact or where to go if this happens		
8. I understand that I may have to disclose some personal illicit information		
9. I understand that no legal harm will come from my sharing illicit information in this study		
10. I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study.		
11. I wish to receive a copy of the findings		
If you answered **YES** to question 11, please provide email address:		
12. I consent to the information gathered during my participation session being used in this research		

Declaration by participant:

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Psychology Research and Ethics Committee (Dr Rebecca Sargisson, phone 07 557 8673, email: rebecca.sargisson@waikato.ac.nz)

Participant's name (Please print):

Signature: Date:

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it. I believe that the participant understands the study and has given informed consent to participate.

Researcher's name (Please print): Wabuya Vaka

Signature: Date:

Appendix D: Online Questionnaire Demographics

Introduction: Hello and thank you for volunteering to participate in my research. Up next is a questionnaire which should take no longer than 20 minutes. This is the final activity to complete your participation. The information from this survey will be used for research purposes only. By clicking next you agree to participate in this survey. Please answer ALL the questions you are presented with as truthfully as you can. Your answers will be held strictly confidential and anonymous.

Please enter your participant number here:

Q1 Gender

- ❍ Male
- ❍ Female

Q2 Age:

- ❍ 18 - 24
- ❍ 25 - 34
- ❍ 35 - 44
- ❍ 45 - 54
- ❍ 55 - 64
- ❍ 65 - 74
- ❍ 75 - 84
- ❍ 85 or older

Q3 Occupation (please select all appropriate boxes):

- ❑ Student
- ❑ Employed part-time
- ❑ Employed full-time
- ❑ Self-employed
- ❑ Unemployed
- ❑ Other _____

Q4 Ethnicity:

- ❑ European
- ❑ Māori
- ❑ Pacific
- ❑ Asian
- ❑ Middle Eastern
- ❑ Indian
- ❑ Latin American
- ❑ African
- ❑ Other _____

Q5 Are you currently, or have you ever been diagnosed with a mental health condition by a professional? (e.g. Learning Disability, Depression, Anxiety, Schizophrenia, ADHD, Autism, etc.)

❍ Yes
❍ No

Q5.1 Please specify what mental health condition?

Q5.2 Please specify when this happened?

Q6 Have you ever suspected you have a mental health condition but never sought professional advice?

❍ Yes
❍ No

Q6.1 Please specify what mental health condition?

Q6.2 Please specify when this happened?

Q7 Have you ever used cannabis (e.g. Marijuana, Hashish, Cannabis oil etc.)?

❍ Yes
❍ No

Q7.1 What type of Cannabis?

❑ Marijuana
❑ Hashish
❑ Cannabis oil
❑ Other _____

Q7.2 When did you last use cannabis?

Q7.3 When did you start using cannabis?

Q8 Do you use any other recreational drugs besides Cannabis? (e.g. LSD, Amphetamines, Ecstasy etc.)

❍ Yes
❍ No

Q8.1 Please specify type of drug/s

Q8.2 Please estimate how often you use these?

❍ Less than one day a month
❍ Once a month
❍ 2-3 times a month
❍ Weekly
❍ Twice a week
❍ 3-4 days a week
❍ Daily

Appendix E: Online *Cannabis Use Problems Identification Test (CUPIT)*

Instruction Part One: In this part of the questionnaire you are requested to complete all of the below questions regarding your Cannabis use. Answers are strictly confidential and anonymous. It is very important to please answer all questions as truthfully as you can. For each question tick the answer closest to your cannabis use over the time range specified.

Q1 On how many days have you used cannabis during the past 12 months? (If there was no pattern to your cannabis use, please make your best estimate.)

- ❍ 1 – 6 days (less than one day a month)
- ❍ 7 – 12 days (an average pattern of one day a month)
- ❍ 13 – 36 days (an average pattern of 2 – 3 days a month)
- ❍ 37 – 52 days (an average pattern of one day a week)
- ❍ 53 – 104 days (an average pattern of 2 days a week)
- ❍ up to 208 days (an average pattern of 3-4 days a week)
- ❍ up to 312 days (an average pattern of 5-6 days a week)
- ❍ up to 365 days (daily/most days)

Q2 Now please think about your recent cannabis use. On how many days have you used cannabis over the past 3 months (90 days)?

- ❍ no days
- ❍ 1 – 2 days (less than one day a month)
- ❍ 3 – 4 days (an average pattern of one day a month)
- ❍ 5 – 9 days (an average pattern of 2 – 3 days a month)
- ❍ 10 – 15 days (an average pattern of one day a week)
- ❍ 16 – 26 days (an average pattern of 2 days a week)
- ❍ 27 – 52 days (an average pattern of 3 – 4 days a week)
- ❍ 53 – 78 days (an average pattern of 5 – 6 days a week)
- ❍ 79 – 90 days (daily/most days)

Instruction: The next section is about over the past 12 months (the past year)

Q3 How many times would you use cannabis on a typical day when you were using? (Note: at least one hour between each new ‘use’)

- ❍ once
- ❍ twice
- ❍ 3 – 4 times
- ❍ 5 – 6 times
- ❍ 7 – 9 times
- ❍ 10 or more times

Q4 How often have you used cannabis first thing in the morning?

- ❍ never
- ❍ once or twice

- ❍ less than monthly
- ❍ monthly
- ❍ one day a week
- ❍ several days a week
- ❍ daily/always

Q5 How much of the average day do you spend/or feel stoned?

- ❍ 0 hours
- ❍ 1 – 2 hours
- ❍ 3 – 4 hours
- ❍ 5 – 6 hours
- ❍ 7 – 8 hours
- ❍ 9 or more hours

Q6 How difficult do you think you would find it to stop using or go without cannabis altogether?

- ❍ not at all difficult
- ❍ a bit difficult
- ❍ quite difficult
- ❍ very difficult
- ❍ impossible

Q7 What was the longest time you went without using cannabis?

- ❍ 6 months or longer
- ❍ 3 – 5 months
- ❍ 1 – 2 months
- ❍ 2 – 3 weeks
- ❍ one week
- ❍ 4 – 6 days
- ❍ 2 – 3 days
- ❍ one day
- ❍ no days at all

Q8 Have you felt that you needed cannabis?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q9 Have you been able to stop using cannabis when you wanted to?

- ❍ never/at no time
- ❍ sometimes (not often)
- ❍ quite often (half the time)
- ❍ very often (usually)
- ❍ always/all the time

Q10 Have you found it difficult to get through a day without using cannabis?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q11 Did your use of cannabis ever interfere with (get in the way of) your work at school, your job, or your home life?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q12 Have you lacked the energy to get things done in the way you used to?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q13 Have you given up things you used to enjoy or were important because of cannabis? (e.g., work, school, sports, hobbies, being with family and friends, etc.)

- ❍ none at all/nothing
- ❍ one or two things
- ❍ quite a few things
- ❍ lots of things
- ❍ everything

Q14 Has anything you had planned, or were expected to do, not happened after using cannabis?(e.g., a family outing, chores, taking care of children, homework, an assignment, appointment, job interview, training, attending school or work, etc.)

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q15 Have you had problems concentrating and remembering things?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Q16 Did you ever use cannabis after you had decided not to?

- ❍ never
- ❍ sometimes
- ❍ quite often
- ❍ very often
- ❍ always/all the time

Appendix F: *Cannabis Use Problems Identification Test (CUPIT)* Scoring Information

cannabis use problems identification test (cupit)© information sheet

The CUPIT was designed to stimulate thought and discussion with cannabis users around the hazards of cannabis use - a valuable component in a health/lifestyle interview

CUPIT screens for:

- cannabis use in past 12 months (frequency, intensity) - See response to Q 1
- cannabis use in past three months - See response to Q 2
- cannabis-induced problems - Score of 12 or higher
- risk of harm (current or 12-month) and dependence - Score of 20 or higher

Cut-off scores	
12 – 20	= Those at risk of developing cannabis use disorder in the following 12 months
20 or more	= Adult or adolescent meets the criteria for current cannabis use disorder (CUD)
82	= The highest score a person can get.

Referral Pathways

Please note; there is some flexibility in interpreting the scores, depending on the cannabis user's circumstances.

Generally, a score between 10 and 20 indicates a need for further discussion/probing around the user's consumption, at the very least.

If the interviewer is trained to conduct this exploration (according to your role, context and the scope of your practice) then you should proceed.

Otherwise, referral to those qualified to conduct this assessment is indicated as the best procedure. Refer to your organisation's guidelines around referral for any perceived problem.

NB: Research shows a sizeable group referred to drug treatment services do not actually present for this treatment.

A *stepped care approach* applies at the initial detection of cannabis use problems:

For those at low risk: an early intervention (cannabis education, discussion about cannabis' role in their life, etc).

For medium risk: education about the health hazards of cannabis use and a brief motivational intervention.

For those at high risk: further in-depth assessment and diagnosis (referral to those qualified to conduct these procedures) and a comprehensive treatment plan.

Each step depends on the response of the client to the earlier intervention.

Who can use CUPIT?
CUPIT can be self- or other-administered. If you are using CUPIT without a professional support person, please call the NZ Alcohol Drug Helpline on 0800 7878 797 if you want further help.

For further diagnostic information, see **Bashford, J., Flett, R. & Copeland, J.** (2010).
The Cannabis Use Problems Identification Test (CUPIT): Development, reliability, concurrent and predictive validity among adolescents and adults. Addiction 105(4), 615-625.

Appendix G: ***Cannabis Abuse Screening Tests (CAST)***

	Never	Rarely	From time to time	Fairly Often	Very Often
1. Have you ever smoked cannabis before midday?	❍	❍	❍	❍	❍
2. Have you ever smoked cannabis when you were alone?	❍	❍	❍	❍	❍
3. Have you ever had memory problems when you smoked cannabis?	❍	❍	❍	❍	❍
4. Have friends or members of your family ever told you that you ought to reduce your cannabis use?	❍	❍	❍	❍	❍
5. Have you ever tried to reduce or stop your cannabis use without succeeding?	❍	❍	❍	❍	❍
6. Have you ever had problems because of your use of cannabis (argument, fight, accident, bad results at school, etc.?)	❍	❍	❍	❍	❍

Appendix H: *CAST* scoring Information

CAST is used both in general population surveys and in cannabis consultation to screen problematic cannabis users and to refer them to the appropriate service. Thresholds enable practitioners to normalise the interview with the person in consultation and to gauge whether the cannabis use pattern is potentially problematic. Two positive answers highlight the need for the person to be careful about use. Three or more positive answers indicates that the use may be problematic and the person should be offered a specialised consultation to obtain help to diminish or stop use, thereby alerting clinicians that a deeper assessment is warranted. Other tests are also in the process of clinical validation in this study, such as the French versions of the CRAFFT and of the ALAC tests used as self-administered evaluation instruments. The ALAC questionnaire (see Appendix A) for the self-evaluation of cannabis use is recommended by the Alcohol Advisory Council of New Zealand (1996). Two positive answers indicate a moderate risk of abuse, and three positive answers indicate a strong risk of abuse. The ALAC questionnaire has not yet been validated, but it aims to assess the harms of reproaches, health problems, dependence and social problems. It appears to be problematic compared with the other tests, as several of the questions do not mention drugs at all.

Appendix I: *Sub-Psychotic Subjective Experiences Scale (SPSES)*

We sometimes experience subtle problems in thinking or feeling. We may not even notice them or consider them a problem. The following questions ask whether you have experienced problems of this type. If you have had these problems, we will ask you to indicate when you first started to experience them.

For each item, select the number that best fits your experience. If you select 1 or higher, please select an option on the right side that is closest to when you first had that type of experience. If you select 0, do not answer the questions on the right just go to the next question.

1. I feel that doing two things at once is impossible even when I try to do the simplest things (like preparing a sandwich while watching TV; or other situations where I try to do two simple things at once)

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

2. I cannot listen to someone and take notes at the same time

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

3. I have difficulties with situations that need divided attention. For example, I cannot listen to the radio and drive, or wash dishes and talk to others, or other similar difficulties

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

4. If I don't focus, other thoughts come into my mind. These thoughts suddenly appear, but they are not related to what I am actually doing

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

5. I sometimes find it difficult to concentrate, because at those times I feel every sound distracts me and brings up unrelated thoughts

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

6. I can't help but keep thinking about other things, which is very distracting

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

7. My mind easily goes blank, as if my thoughts disappear whenever I start thinking

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life

☐ Within the past 1 year
☐ Within the past 3 months
☐ Within:

8. Sometimes my thoughts just stop, or are suddenly gone like being cut off

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

☐ It's been a problem for most of my life
☐ Within the past 1 year
☐ Within the past 3 months
☐ Within:

9. I often lose my train of thought because other thoughts enter my mind

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

☐ It's been a problem for most of my life
☐ Within the past 1 year
☐ Within the past 3 months
☐ Within:

10. I cannot think of the right words and have to use other, less precise, words

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

☐ It's been a problem for most of my life
☐ Within the past 1 year
☐ Within the past 3 months
☐ Within:

11. My answers are not clear. I ramble somewhat until I find something appropriate to say

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me

0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

12. I lack the words to express my thoughts and have to search my mind for them

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

13. When I am stressed my mind gets chaotic and I have problems thinking straight

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

14. My thoughts sometimes jump from one subject to another so much that they are actually not related to each other

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

15. I have felt overwhelmed by a great number of thoughts in my head at the same time

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

16. When I am reading something, watching TV, or listening to the radio, I have had the experience that there was specific meaning there for me. Of course I knew straight away that it was just my imagination

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

17. Sometimes I have felt that people were looking at me in public places or streets, although I knew it wasn't true

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

18. Sometimes when I hear something, like a dog barking, a cat meowing, or a noise from cars or appliances, out of the blue I have felt they may be occurring because of me, and then I told myself that this is nonsense

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

19. Sometimes an object really seems to stand out from the rest of what I see. My eyes then have to fix on it even if I don't want to look at it

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

20. A small detail in my surroundings can catch my attention and I have to look at it for a while without really wanting to, like I was spellbound

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life
- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

21. A particular feature (for example, something on the wall, or part of a person's face or body part) can quickly catch my attention out of the blue, and I have to hold my attention on it for a while

1. Happens. Less than once a month; not bothering me
2. Several times in a month; occasionally bothering me
3. Several times a week; bothering me a bit
4. Happens almost every day; really bothering me
0. Never happens to me, nor a problem

- ☐ Within the past 1 year
- ☐ Within the past 3 months
- ☐ Within:

If 1 or greater, when did you first have this problem?

- ☐ It's been a problem for most of my life

Appendix J: Digit-Symbol Coding Subtest