Test re-test reliability of the Speech, Spatial, and Qualities of Hearing scale 12 item short form: For non hearing aid wearers using pen and paper administration method

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Abstract

Background

The available self-report measures of hearing ability do not address challenging listening environments thoroughly (Gatehouse & Noble, 2004). These situations are often where individuals with hearing impairment encounter the most difficulty (Gatehouse & Noble, 2004). The Speech, Spatial and Qualities of Hearing Scale 12 item short form (SSQ12) is a shortened version of the Speech, Spatial and Qualities of Hearing Scale (SSQ) intended for clinical use (Noble, Jensen, Naylor, Bhullar, & Akeroyd, 2013).

To date the reliability of the SSQ12 has not been investigated. This study addressed: 1) the overall reliability of the SSQ12 over the three time points: week 0 (T0), week 6 (T1), and week 12 (T2); 2) the reliability of the SSQ12 subscales over the three time points (T0, T1, and T2); and 3) the presence of patterns between the given response and measured factors.

Method

This observational study recruited 21 participants to partake in the completion of the SSQ12. The SSQ12 was completed by all participants at three time points at 6 week intervals. Participant information was collected on age, gender, ethnicity, relationship status, income, education level, severity, audiometric thresholds, and Hearing Handicap Questionnaire (HHQ) (Gatehouse & Noble, 2004) average score.

Results

Non-parametric analyses of the data showed strong correlations exist between subscale and total scores across the three administration points with the exception of the T0-

T2 spatial subscale correlation. Further analysis showed the presence of significant relationships between various subscales and the measured variables: age, severity, better ear puretone average (BEPTA), worse ear puretone average (WEPTA), and HHQ average at each of the administration time points.

Conclusion

The SSQ12 is a reliable measure and can be used in a clinical setting to observe true changes in hearing status as a result of intervention. It is recommended the audiologist administrating the SSQ12 refers to the critical differences to determine a true effect, as they differ depending on subscale and overall score. An additional recommendation is for the audiologist to limit the time interval at which they administer the SSQ12.

It would be beneficial to further investigate the reliability of the SSQ12 for this population through the interview administration method. Additionally, the reliability for adults with hearing loss and hearing aids for both methods of administration should be investigated in the future in order to determine normative values.

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List of Abbreviations

ABIMWT – Arthur Boothroyd Isophonemic Monosyllabic Word test

BEPTA – better ear puretone average

ERC – Eriksholm Research Centre

HHQ – Hearing Handicap Questionnaire

HHQ Avg – Hearing Handicap Questionnaire average score

HINT – Hearing in Noise Test

MRC – MRC Institute of Hearing Research Scottish Section

PTA – puretone average (0.5, 1, 2, and 4 kHz)

QuickSIN – Quick Speech-In-Noise test

SSQ – Speech, Spatial and Qualities of Hearing Scale

SSQ12 – Speech, Spatial and Qualities of Hearing Scale 12 item short form

SSQ12-B – Speech, Spatial and Qualities of Hearing Scale 12 item benefit short form

SSQ12-C – Speech, Spatial and Qualities of Hearing Scale 12 item comparison short form

SSQ15 – Speech, Spatial and Qualities of Hearing Scale 15 item short form

SSQ5 – Speech, Spatial and Qualities of Hearing Scale 5 item short form

SSQ-B – Speech, Spatial and Qualities of Hearing Scale benefit version

SSQ-C – Speech, Spatial and Qualities of Hearing Scale comparison version

T0 – first administration at week 0

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T2 – second administration at week 6

T3 – third administration at week 12

UC – University of Canterbury

UNE – University of New England

WEPTA – worse ear puretone average

1. Literature Review

1.1 Hearing Impairment

1.1.1 Overview

The World Health Organization (2016) estimated that 5% of the world's population (360 million people) have a disabling hearing impairment. A disabling hearing impairment is defined as a threshold of 40 dB HL in the better ear as measured by puretone audiometry (World Health Organization, 2016). Hearing impairment, however, is considered to be anything outside the range of normal – an audiometric threshold greater than 20 dB HL. Any degree of hearing impairment can impact an individual's ability to hear speech and/or sound (World Health Organization, 2016).

Hearing impairment is quantified by audiometric thresholds that are displayed for each of the tested frequencies in the form of an audiogram. Auditory thresholds are defined as the minimum amount of sound energy required to initiate transference of sound though the outer, middle, and inner ear, and elicit a hearing response from the tested individual (Rajamanickam, 2002). Thresholds are routinely tested for the frequency range 250 – 8000 Hz. High frequency audiometry obtains thresholds for frequencies greater than 8000 Hz (up to 16,000 or 20,000 Hz) and is often used in monitoring the effects of ototoxic drugs on hearing (Durrant et al., 2009). When thresholds are plotted in an audiogram, they are able to detail the severity and configuration of hearing; when bone conduction is completed, the type of hearing impairment can also be deduced.

The severity of hearing impairment can be classified in multiple ways (Margolis & Saly, 2007). For the purposes of this thesis, the classification developed by Jerger and Jerger (1980) will be used. Their method of classification has been defined (see Table 1).

Table 1

Classification of hearing impairment.

Degree of hearing impairment	**Normal**	**Mild**	**Moderate**	**Moderately -Severe**	**Severe**	**Profound**
dB HL	-10 to 20	21 to 40	41 to 55	56 to 70	71 to 90	>91

Notes. Adapted from *Jerger and Jerger (1980).*

There are three terms: conductive, mixed and sensorineural, used to categorise the types of hearing impairment. Conductive hearing impairments are due to issues in the mechanical transfer of sound from the outer or middle ear, to the inner ear. Sensorineural hearing impairments are due to disturbances in the electrical transfer of sound by the cochlea, or retrocochlear structures. Mixed impairments are a combination of conductive and sensorineural impairments.

There are many causes of hearing impairment. In adults, as is the focus of this thesis, causes of hearing impairment can include ageing (presbycusis), occupational noise exposure, and injury (World Health Organization, 2016).

1.2 Intervention

Individuals with hearing impairment, who feel their quality of life is negatively affected, may seek advice from, or be directed to an audiologist. Audiologists are able to provide knowledge on, and recommend a variety of interventions for individuals with hearing impairment. They take into account the type and severity of impairment to select one (or many) option(s) that would be suitable. Hearing aids, cochlear implants, and hearing assistive technologies are some of the interventions available to target impairment of hearing function (Boothroyd, 2007; Sprinzl & Riechelmann, 2010).

Hearing aids target function by amplifying frequencies of sound according to the degree of impairment (Sprinzl & Riechelmann, 2010). They are available in many shapes and sizes, such as behind the ear, in the ear, and completely in the ear. This makes them applicable to most individuals as adjustments can be made where needed for things such as poor eye sight, poor fine motor skills, and cosmetic purposes. Current hearing aids are digital, allowing for automatic adjustment in response to environmental noise as well as reducing acoustic feedback (Sprinzl & Riechelmann, 2010).

Hearing assistive technologies may be paired with, or be independent of hearing aids and cochlear implants (Sprinzl & Riechelmann, 2010). Those paired with hearing aids can include remote microphones or frequency modulation systems which allow for the direct transfer of the speaker's voice to the hearing aid, when the speaker is wearing a microphone. Technologies that are independent of hearing aids can alert individuals with hearing impairment using auditory, visual, or tactile senses (Sprinzl & Riechelmann, 2010). A good example of this is an amplified telephone as it amplifies the speaker's voice. It can also include a visual cue for incoming calls such as a flashing light and/or large buttons for easy use.

Cochlear implants, middle ear implants and bone anchored hearing aids are all forms of surgical intervention for hearing impairment. Middle ear implants and bone anchored hearing aids may be indicated when there are factors contraindicating the use of hearing aids, such as a significant conductive component to the impairment. Cochlear implants are considered when hearing aids are no longer beneficial as they cannot provide the gain required (Labadie, Carrasco, Gilmer, & Pillsbury, 2000). However, while this option can be recommended by an audiologist, all surgical interventions are at the discretion of otorhinolaryngologists.

1.2.1 Prevalence of Hearing Impairment in New Zealand

The prevalence of hearing impairment within New Zealand is not well documented. In 2013, a disability survey reported that hearing impairment affected 380,000 people - 9% of the population at the time (MacPherson, 2014). Exeter, Wu, Lee, and Searchfield (2015) estimated that with New Zealand's aging population, those 14 years and older with any level of hearing impairment, will increase from 330,000 (the authors estimate of the prevalence of hearing impairment in 2011) to 683,000 by 2061. While not all degrees of hearing impairment require intervention, this paper is an indication of the future burden for those working in hearing related health fields, as twice the amount of people may eventually require their services. With an increased burden there is a greater need for a well-rounded approach to treating individuals with hearing impairment. If people are to appreciate the benefit of intervention, and the time of audiologists is to be used effectively, the manner in which audiologists approach this consumer driven field must adapt. Adaptations to current practice can include using questionnaires to identify the areas in which most difficulties are faced. This allows for counselling and intervention(s) to be adjusted accordingly.

1.3 Impact of Hearing Impairment

It is well researched that those with untreated hearing impairment experience a decreased quality of life (Dalton et al., 2003; Lotfi, Mehrkian, Moossavi, & Faghih-Zadeh, 2009; Lutman, Brown, & Coles, 1987; Mulrow, Aguilar, Endicott, Tuley, et al., 1990). This is likely due to the difficulties they encounter at a social, functional, and economic level. Functionally, individuals with hearing impairment have difficulties communicating (Fook, Morgan, Sharma, Adekoke, & Turnbull, 2000). Difficulties in communication have social and emotional implications such as feelings of isolation, frustration, and anxiety (Fook et al., 2000; Lotfi et al., 2009; Mulrow, Aguilar, Endicott, Velez, et al., 1990). There are also a number of studies linking depression to hearing impairments (Herbst & Humphrey, 1980; Huang, Dong, Lu, Yue, & Liu, 2010; Strawbridge, Wallhagen, Shema, & Kaplan, 2000). While these difficulties are likely to increase with increased severity of the hearing impairment, Mulrow, Aguilar, Endicott, Velez, et al. (1990) reported social and emotional difficulties were present in individuals with mild to moderate hearing impairments. At an economic level, adults with hearing impairment have higher unemployment rates and are likely to find it difficult to obtain and keep employment (Tucci, Merson, & Wilson, 2010)

Anxiety and frustration are not only felt by the individual with hearing impairment, but, also by their spouse or close relatives, otherwise referred to as a communication partner (Armero, 2001). These feelings are attributed to difficulties in everyday communication between individuals with hearing impairment and their communication partners, particularly in background noise; and the stress of having to repeat themselves and for others involved in conversation (Stark & Hickson, 2004). Scarinci, Worrall, and Hickson (2008) reported particular concerns of spouses regarding their partners' awareness, or lack of, to signals and alarms that are intended to warn people. These spouses also experienced the strain of increased responsibility by acting as an intermediary for their spouse with hearing impairment during communication tasks such as telephone usage (Scarinci et al., 2008).

1.4 Rehabilitation Options

The primary goal of rehabilitation is the restoration of an individual's quality of life (Boothroyd, 2007). For adults, audiology rehabilitation services focus on understanding their hearing impairment, optimising aid use (including the use of assistive technologies), and the use of communication strategies (American Speech-Language-Hearing Association, 2015). Aural rehabilitation can be categorised into four components: sensory management, instruction, perceptual training, and counselling (Boothroyd, 2007).

Sensory management focusses on the improvement of auditory function (Boothroyd, 2007). This can be achieved through the use of intervention methods previously discussed, such as hearing aids (see Section 1.2). The improvement of communicative abilities does not end at the provision of hearing aids and other interventions, as they are not enough to fully restore hearing function (Chisolm, Arnold, Wong, & Hickson, 2012; Sweetow & Palmer, 2005). Instruction works in unison with sensory management to increase the likelihood of a positive outcome from sensory management (Boothroyd, 2007). This is partially achieved by setting realistic expectations for the hearing aids. As mentioned previously, intervention cannot restore normal hearing. In addition to this, the amplification of frequencies lost over the course of the hearing impairment means that the individual must learn to listen again.

Perceptual training focusses on activity by enhancing perceptual skill (Boothroyd, 2007). This aims to optimise the ability to hear for an individual with hearing impairment. This form of training may involve the individual learning about the production of speech sounds and how to utilise visual cues, such as, facial expression to help gain information regarding the conversation (Wong & Hickson, 2012). Counselling addresses issues in participation and quality of life that arise from the client's hearing impairment (Boothroyd, 2007). This can involve groups of individuals with hearing impairment coming together with or without their communication partners. These groups may support individuals with hearing impairment to help them cope and learn from the experiences of other group members who are also hearing impaired (American Speech-Language-Hearing Association, 2015).

The outcome of rehabilitation can be influenced by the rehabilitative personnel's experience and focus within each of the rehabilitation categories. The individual with hearing impairment also influences the outcome of rehabilitation. This may be beyond the control of the rehabilitative personnel and may include factors such as the individual's motivation, personality, support network, and the function of other sensory systems such as vision (Boothroyd, 2007).

1.5 Outcome Measures

Outcome measures allow audiologists to evaluate the success of treatment in relation to their client's rehabilitation goals (Kricos & Lesner, 2000; Montgomery, 1994). The evaluation of treatment relates to its efficacy and effectiveness. Treatment efficacy refers to treatment benefit under optimal conditions, while, treatment effectiveness refers to treatment benefit under real life conditions (Frattali, 1998).

In audiology, although there are a plethora of tools available, there is no standard measure that is able to adequately encompass all potential outcomes (Saunders, Chisolm, & Abrams, 2005). Instead, outcome measures are selected based on their conceptual consistency with the intervention being provided (J.-P. Gagné, 2003). The available outcome measures of intervention can be broadly categorised into objective and subjective measures. Traditionally, objective measures were more favoured and relied on to show that the intervention was working. However, more recently, subjective measures have become more favourable (Cox, 2003; Mendel, 2007)

1.5.1 Objective Measures

Objective measures show benefit based on empirical evidence, and as a result, do not require opinions or judgements from the wearer of the hearing aid (Cox, 1999; Jerram & Purdy, 2001). They are a necessary part of outcome measure as hearing aid outcome can be affected by an individual's personality, emotional state, and preconceived notions on hearing aids (Mendel, 2007; Saunders et al., 2005). Non-blinded empirical research on advancements in hearing aid technology, from analogue to digital hearing aids, have shown that there is no measureable benefit in improving the understanding of speech, although subjective measures reported improvements in understanding speech (Valente, Fabry, Potts, & Sandlin, 1998). Additionally, a single-blinded study by Bentler, Niebuhr, Johnson, and Flamme (2003) showed a significant labelling effect on subjective measures when hearing aid wearers were made aware of the level of technology in the hearing aid. These studies suggest the presence of bias in the participant response to subjective measures due to perceived technology levels.

There are many objective measures used to examine hearing aids. These include speech recognition in quiet and noise, insertion and functional gain, aided loudness judgements, aided quality judgements, and speech intelligibility index (Cox, 2003). However, many of these are laboratory assessments and are limited in their depiction of hearing aid function in the real world (Cox, 2003; Mendel, 2007).

1.5.2 Gain

There are two categories of gain: functional and insertional. Functional gain is measured by the aided and unaided thresholds in a sound field, whereas insertion gain, measures the pressure difference in aided and unaided situations in the ear canal (Dillon, 2012). Insertion gain is routinely used during hearing aid fittings as verification that the hearing aid is meeting the prescription targets for the given hearing impairment (Dillon, 2012). The insertion gain only provides information about hearing aid function. Verifying that the correct amount of gain is being provided does not necessarily correlate to an improvement in hearing in real world listening situations (Mendel, 2007). This is because communication difficulties for individuals with hearing impairment are personalised and are dependent on, but not limited to, the individuals' circumstances and lifestyle (Cox, 2003).

1.5.3 Speech Testing

Individuals with hearing impairment often comment on their difficulties understanding speech (Killion, Niquette, Gudmundsen, Revit, & Banerjee, 2004). Speech testing allows for an objective and direct assessment focussed on the understanding of speech with or without hearing aids (Dillon, 2012). There are many speech tests available such as the Arthur Boothroyd Isophonemic Monosyllabic Word test (ABIMWT) (Boothroyd, 1968), Hearing in Noise Test (HINT) (Nilsson, Soli, & Sullivan, 1994), and Quick Speech-In-Noise test (QuickSIN) (Killion et al., 2004). The latter two tests were developed to provide a more accurate depiction of real world listening environments, due to the presence of background noise. It is important to note that speech in noise tests are a compromise between reproducibility and realism (Killion et al., 2004). This compromise is made when choosing the components comprising speech and background noise (Killion et al., 2004).

Speech tests are not a reliable gauge of increasing speech understanding in more challenging listening situations, such as multiple speakers, due to the ideal listening environment in which speech testing is conducted (Cox, 2003). This can been seen in a clinical setting where there is often a disassociation between speech recognition scores that show benefit and the report of dissatisfaction by the hearing aid wearer (Saunders et al., 2005). Some studies have found hearing aid wearer preference for hearing aid settings do not affect their speech intelligibility scores (Bentler, 1992; Horwitz, Turner, & Fabry, 1991).

Other research has shown that the benefit measured by speech testing is not a predictive measure of the benefit reported by hearing aid wearers (Cox & Alexander, 1992; Haggard, Foster, & Iredale, 1981). This does not, however, mean that speech testing is not a useful measure. In a clinical setting, it allows the audiologist to demonstrate hearing aid benefit to the hearing aid wearer or communication partners (Dillon, 2012). It also allows for discussion between the audiologist and hearing aid wearer about communication strategies e.g. visual cues which may require further referral for training (Dillon, 2012).

1.5.4 Subjective Measures

Clinical practice in audiology is largely focussed of the diagnosis of hearing impairment (Erdman, 1993). However, as healthcare becomes increasingly more consumer driven, the client's opinion of treatment has become an accepted and valid indicator of treatment success (Cox, 2003; Mendel, 2007). As previously mentioned, objective measures such as gain and speech testing cannot reliably predict increases in speech intelligibility as a result of intervention. They are also not able to inform the audiologist about any improvements in their client's quality of life due to intervention. This is an important area that must be addressed in order to evaluate the efficacy of treatment (Weinstein, 1997). Additionally, the audiogram is not an accurate indicator of the communication difficulties faced by an individual with hearing impairment (Demorest & Walden, 1984; Kielinen & Nerbonne, 1990).

Subjective measures allow for communication difficulties, disabilities, and handicaps associated with hearing impairment to be addressed. This in turn, can demonstrate the benefit of hearing aid use to the client, which is becoming increasingly important for audiologists (Cox, 2003; Erdman, 1993). While subjective measures are quickly becoming the "gold standard" of hearing aid benefit, it is important that objective measures continue to be used to help validate the client's opinions and fitting outcomes (Mendel, 2007).

1.5.5 Self-Report Measures

Self-report measures are the only way in which cognitive and affective experiences can be assessed (Erdman, 1993). This measure involves respondents answering questions about their thoughts and/or feelings, but are not limited to these responses (Jackson, 2015). The questions can be open or closed and posed by interviewers or in a questionnaire format. The questionnaires may be administered pre and post intervention, with any benefit being reflected in score differences (J.-P. Gagné, 2003). Alternatively, questionnaires can be administered post intervention with change being reflected in the scores reported (J.-P. Gagné, 2003). In a clinical setting, the use of validated self-report measures is a feasible and useful tool for clinicians to gauge their client's thoughts and behaviours (Bender, Milgrom, & Rand, 1997; Hawkshead & Krousel-Wood, 2007).

Erdman (1993) states there are two fundamental reasons for using self-report in audiology. The first, is that it allows for the assessment of hearing impairment related disability and handicap. By incorporating these into clinical audiology practice, the service provided becomes more comprehensive in nature (Erdman, 1993). This fundamental reason is supported by Cox et al. (2000), who also states that in order to assess rehabilitative outcomes an "optimal measure will assess benefit in terms of both disability…and handicap reduction…" (p107S). Second, self-report is a versatile and efficient way of detailing and keeping track of the difficulties the client is expecting their audiologist to remedy (Erdman, 1993).

These measures can be further categorised into behavioural, cognitive and affective self-report measures (Jackson, 2015). Behavioural self-report measures usually relate to asking an individual to report how often they perform a task (Jackson, 2015). Cognitive self-report measures ask an individual their thoughts about something (Jackson, 2015). Affective self-report measures require responses about their feelings towards something (Jackson, 2015).

While self-report measures are a method of gauging thoughts and opinions, they rely on the individual's responses to be truthful (Jackson, 2015). Therefore, using this method the researchers and clinicians must be wary of the truthfulness of responses as they may be marred by what is considered socially acceptable, the ability to accurately recount past events, and bias in self-reflectance (C. Gagné & Godin, 2005; Hawkshead & Krousel-Wood, 2007). Responses are also subject to the responder's emotions at the time. For the purposes of clinical use, subjective perception may have greater relevance than the accuracy of the information provided as it indicates specific disabilities and handicaps (Erdman, 1993).

1.6 Psychometric Properties of Self-Report Measures

1.6.1 Validity

Validity can be defined as how truthful an inference is when based on relevant evidence (Nunnally & Bernstein, 1994; Shadish, Cook, & Campbell, 2002). It is important, as a measure has little long term value if the inferences made cannot be considered valid. Validity can be broadly categorised into external and internal validity. External validity refers to the ability to generalise the study findings e.g. to other populations and geographical locations. Internal validity refers to the researcher's confidence in the results of their study. When examining internal validity, it is important to note that it mainly consists of construct, predictive, and content validity.

Construct validity is a measure of mental attributes, such as customer satisfaction. As these constructs are inherently abstract, they are measured by defining relevant variables, specifying observable measures, and ensuring consistency between the measurement properties and the fundamental theory. Predictive validity refers to the formation of a statistical relationship with a defined criterion. Therefore, conditions that affect both the predictor and criterion must be taken into consideration. Content validity is the most theoretical and refers to how representative a sample is of the content (Nunnally & Bernstein, 1994).

The reasoning behind the use of self-report in audiology is to increase the information known about hearing impairment (Demorest & DeHaven, 1993). Validity is not often reported on, rather, positive correlations between self-report scales and hearing impairment are considered to be evidence of construct validity (Demorest & DeHaven, 1993). This is due to the relationship assumed to exist between the two. Evidence of validity is not sufficient for clinicians to use self-report measures if the information for or against their use is not available, therefore, more systematic research is needed (Demorest & DeHaven, 1993).

1.6.2 Reliability

Reliability can be defined as the stability or consistency of a measure over time (Nunnally & Bernstein, 1994). Another definition may be that something can be considered to be reliable when it is free from random error, however, you can never completely eliminate random error (Nunnally & Bernstein, 1994). Observations are considered repeatable when the findings are reproducible in the following situations: others perform the measurements, different instruments are used to measure the identical object, and when there are variations in the conditions which measurements are being performed (Nunnally & Bernstein, 1994).

Reliability of the SSQ12

Methods requiring two test administrations for establishing reliability include the alternate form method and the test re-test method (Crocker & Algina, 1986).

The alternate form method, as the name indicates, requires the development of two tests that are alike. Both forms of the test are then administered to the participants in a limited time period. The two sets of test scores are analysed to produce the coefficient of equivalence. A high coefficient of equivalence is indicative of the ability to interchange the two test scores with a greater degree of confidence (Crocker & Algina, 1986). There is no set standard for how large a coefficient of equivalence should be to be considered acceptable for alternate form estimates of reliability (Crocker & Algina, 1986).

The test re-test method is the process of administering tests at multiple time points with the expectation that the test administered will produce similar results at all intervals administered. This method of reliability is dependent on the time interval being sufficient enough that it is not an individual's memory being tested, but, also that the elapsed time is not sufficient for the criteria being measured to change (Nunnally & Bernstein, 1994). Another factor likely to influence the test re-test reliability of a questionnaire is the administration method.

There are two commonly used methods of administration. First, pen and paper administration, which is considered the gold standard, and the interview administration method (Singh & Pichora-Fuller, 2010; Thorén, Andersson, & Lunner, 2012). The interview method carries the risk of being affected by social and psychological processes (Singh & Pichora-Fuller, 2010). As this method of testing is primarily concerned with the consistency of test responses over time, errors must be considered. These errors impact responses and can include changes in the emotional state of the individual taking the test, administration errors, and scoring errors. The impact of these errors is estimated through the analysis of the test scores over time (Crocker & Algina, 1986). The correlation coefficient produced through such an analysis is referred to as the coefficient of stability (Crocker & Algina, 1986). Hardly any standards exist when considering what the minimum value of the coefficient of stability is to be considered acceptable (Crocker & Algina, 1986). However, this information is critical in practical testing situations (Crocker & Algina, 1986). Nunnally and Bernstein (1994) deem a questionnaire with a reliability of 0.8 or greater sufficient for clinical use. Although, if important decisions are made based on the score then a reliability of 0.95 is the desired reliability score (Nunnally & Bernstein, 1994).

Test re-test reliability focuses on the short term i.e. day to day effects on scores (Demorest & DeHaven, 1993). Focusing on the changes that occur over longer periods of time is referred to as test re-test stability (Demorest & DeHaven, 1993). Both the short term and long term analyses are of clinical significance (Demorest & DeHaven, 1993). An evaluation administered at any point in time should not be affected significantly by daily changes. Additionally, when an evaluation is used to measure changes over time it is important to know that, in the absence of intervention, the client's score would not change. By using participants consisting of adults with hearing impairment and no hearing aids, the long term stability of the Speech, Spatial, and Qualities of Hearing Scale 12 item short form (SSQ12) (Noble et al., 2013) is being tested. We would expect that in the absence of intervention their scores would not change, indicating that if an intervention were to be implemented, the SSQ12 would be capable of evaluating these changes as reflected by their scores.

In addition to test re-test reliability, the coefficient alpha is one form of analysis for internal consistency – the reliability estimate when based on the mean correlation between test items (Bernstein, 1994; Crocker & Algina, 1986). Quite often, the coefficient alpha is a good reliability estimate as a significant error source in static constructs in content sampling, and it is sufficiently sensitive to sources of variation in sampling (Nunnally & Bernstein, 1994).

1.7 Speech, Spatial and Qualities of Hearing Scale

1.7.1 Overview

Gatehouse and Noble (2004) reasoned that a new measure, such as the Speech, Spatial, and Qualities of Hearing Scale (SSQ), was necessary as current disability measures do not address the following aspects of scenic analysis:

- The three-dimensional and temporally dynamic nature of listening environments.
- Real listening situations including differing room reverberation qualities, multiple sources of sound (both speech and non-speech) and the need for the listener to adapt to these contexts by locating, identifying and switching their attention in order to follow these cues in a communicatively competent manner.
- They underestimate the multiple other contributions to increased listening difficulty.

To address the above, Gatehouse and Noble (2004) proposed a 49 item questionnaire to be used in conjunction with the Hearing Handicap Questionnaire (HHQ) (Gatehouse & Noble, 2004). This 49 item questionnaire would focus on the disability experienced by an individual with hearing impairment relative to their perceived handicap. The terms disability and handicap have been defined by the World Health Organization (1980) as “ any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being” (p.28) and “a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfilment of a role that is normal (depending on age, sex, and social and cultural factors) for that individual" (p.29) respectively. The 49 items were designed to best represent each of the three sections:

- Speech hearing - a 14 item section covering realistic speech hearing circumstances including speaker visibility and numbers, opposing sounds, and various conversation environments (multiple speakers, reverberation, and quiet).
- Spatial hearing - consists of 17 items related to a hearing impaired individual's ability to judge the dynamic (directional and distance) elements of speech.
- Other qualities - the final 18 items form the other qualities section. Other qualities encompass the ability to separate and identify sounds, how clarity and tone is perceived, and the amount of effort required to listen.

Gatehouse and Noble (2004) concluded that the SSQ has the potential to act as a measure of evaluating intervention, particularly concerning binaural function.

1.7.2 Sources of Variability

Significant predictors of outcome should be identified for any questionnaire as they may vary from the expected contributors (Cox et al., 2000). In regards to the SSQ, it would be expected that hearing impairment, hearing asymmetry, and age are significant predictors of outcome (Moulin & Richard, 2016). Those predictors not expected to alter SSQ outcomes may include gender and education level (Moulin & Richard, 2016).

1.7.2.1 Age.

Banh, Singh, and Pichora-Fuller (2012) further analysed the SSQ by reporting on the effect age could have on the responses reported in the SSQ, by administering to two age groups (younger and older) of 48 adults with normal hearing with mean ages of 18.6 (SD = 1.0) and 70.0 (SD = 4.1) years old respectively. The study reported significantly higher scores by the younger group on 42 out of 46 items averaging scores of 8.8 (SD = 0.6) in comparison to the older group score average of 7.7 (SD = 1.2). Banh et al. (2012) concluded that the establishment of scores across the different age groups of normal hearing adults would assist in setting realistic targets for adults with hearing impairment. As previously mentioned, setting realistic expectations of hearing aids for individuals with hearing impairment plays an important role in hearing aid outcome. Therefore, this may be something to consider for future research.

Moulin and Richard (2016) also reported a significant correlation (r = -0.038) between age and the speech items for the older participant group with hearing impairment (n = 216; mean age 54.2 years, SD = 17). It was observed that as age increased, there was a tendency for the speech in speech contexts scores to decrease.

In contrast, Noble and Gatehouse (2004) reported no significant correlation between SSQ score and age. Noble and Gatehouse (2004) observed the SSQ scores of two participant groups: symmetrical hearing impairment (n =103; mean age = 70.1 years, SD = 8.3) and asymmetrical hearing impairment (n = 50; mean age = 72.8 years, SD = 7.5). The calculated rank correlations between age and SSQ total score were not significant at r = -0.01 and r = -0.03, respectively.

1.7.2.2 Gender.

Moulin and Richard (2016) reported gender to be a significant predictor for the speech and spatial subscales. A multi-regression analysis of these two subscales suggested that women were likely to have lower spatial scores and higher speech scores. The authors suggest the lower scores for the spatial subscale may be due to the differences in visuo-spatial ability that are gender linked. Please refer to Voyer, Voyer, and Bryden (1995) for more information on visuo-spatial ability.

1.7.2.3 Education.

Moulin and Richard (2016) listed 7 items (speech: 9; spatial: 14, 15, and 16; and qualities: 1, 2, and 8) for which level of education acted as a significant predictor. For these items an increased score was expected with increasing years of education. Akeroyd, Guy, Harrison, and Suller (2014) and Moulin, Pauzie, and Richard (2015) both completed factor analyses on the English version of the SSQ. They both found very low communalities for spatial subscale items: 14, 15, and 16. Moulin and Richard (2016) suggest these items are more cognitively challenging; and therefore, the level of education plays a significant role when being able to understand and respond to the items.

1.7.2.4 Hearing Impairment and Asymmetry.

The original SSQ study by Gatehouse and Noble (2004) (n = 153, 80 females and 73 males; and better ear puretone average (BEPTA) 38.8 dB (SD = 15.5) and worse ear puretone average (WEPTA) 52.7dB (SD = 24.4)) observed a significant correlation (a majority with a significance of $p < 0.01$) between many of the SSQ items and BEPTA. When analysing asymmetry, with BEPTA controlled for, significant correlations at the $p < 0.01$ and $p < 0.05$ level were observed for select items across all subscales. The spatial subscale items presented with the highest number of significant correlations with 13 of the 17 items significantly affected by asymmetry.

In another study by Noble and Gatehouse (2004), they investigated the potential differences that may arise in the SSQ scores due to symmetrical and asymmetrical hearing impairment. The participant groups were defined as symmetrical (n = 50; BEPTA = 38.9 (SD = 15.9); and WEPTA = 42.3 (SD = 15.7)) and asymmetrical (n = 103; BEPTA = 38.7 (SD = 14.9); and WEPTA = 74.2 (SD = 25.2)) where asymmetry was defined as a difference of greater than 10 dB between the puretone average (PTA) of both ears. In line with the previous study the BEPTA for both groups was significantly correlated to the SSQ total score (ρ = -0.43 – -0.55). When investigating the WEPTA, a significant correlation was only observed in the symmetrical group (ρ = -0.40). As predicted by Noble and Gatehouse (2004), it was reported that greater disability, indicated by a lower score, was experienced in the spatial hearing category for the asymmetrical group than the symmetrical group. In general, the asymmetry group experienced greater disability throughout all three SSQ categories than the symmetrical group. The authors concluded there was potential for the SSQ to be used in the evaluation of outcomes when comparing bilateral versus unilateral intervention methods.

A later study by Moulin and Richard (2016) was in agreement that hearing impairment asymmetry influenced SSQ score, particularly for the spatial subscale. The authors reported a variance of 9% on SSQ scores due to asymmetry. This variance increased to 14% for the spatial subscale. In contrast to previous studies, investigation by Singh and Pichora-Fuller (2010) (n = 159, mean age = 72.8 years, SD = 5.6) found no significant relationship between BEPTA and WEPTA with SSQ performance at any time point for all four of their administration groupings.

1.7.3 Auditory Scene Analysis

The theory underlying the development of questions in the SSQ (Gatehouse & Noble, 2004) is the concept of auditory scene analysis. This was first introduced by Bregman (1990). Auditory scene analysis is the procedure utilised by the auditory system to decipher individual sounds from the mixture of sounds heard by the ear in real world situations (Bregman, 1990). In order to achieve sound separation, the sum of pressure waves reaching the ear must be analysed through heuristic processes. Heuristic processing utilises learned memories to analyse the incoming signal. By analysing signals in this manner, there is a reduction in the cognitive effort required. Therefore, the regularities present in the incoming signal will be grouped as one sound (A), while the other components will be grouped as another sound (B). These regularity groupings can determine pitch, timbre, loudness, and spatial position (Bregman, 1994).

These regularity groupings rely on at least two forms of grouping: sequential integration and simultaneous integration (Bregman, 1990, 1994). While these will be described separately, they are not independent of one another. Sequential integration can be described using auditory stream segregation. When a high and a low frequency puretone of equal duration alternate, they form a repetitive cycle of sounds. At slower cycle speeds the rhythm is perceived to contain all frequencies within the tone, including the highest and lowest frequencies in the cycle. At higher cycle speeds, the sound will be perceived as two separate frequency tones – one high pitched and one low pitched.

Simultaneous integration bases its groupings upon an incoming signal that is heard at a point in time and is likely to be part of the same sound (Bregman, 1994). In the incoming signal all the sounds are combined. In order for the auditory system to correctly recognise the different components of sound, it must be able to use the properties to group those of a common source. For example, speech is a periodic sound, therefore, when the auditory system detects a periodic sound of a common fundamental frequency, there is increased likelihood that this subset will be treated as a distinct sound source. Periodicity is not the only cue identifying common sources of sound. Other identifiers can include: synchrony of onsets and offsets of components of incoming signal, spatial location of frequency components, identical amplitude fluctuation patterns between differing frequency components, and frequency separation of components (Bregman, 1994; Büchler, Allegro, Launer, & Dillier, 2005).

Reliability of the SSQ12

1.7.4 Hearing Handicap Questionnaire

Based on the Hearing Disabilities and Handicaps Scale (Hétu et al., 1994) and Glasgow Benefit Inventory (Robinson, Gatehouse, & Browning, 1996), the HHQ was developed by Gatehouse and Noble (2004). The HHQ is completed alongside the SSQ and measures the social and personal effects associated with hearing impairment. Gatehouse and Noble (2004) intended to separate social and personal consequences from measures of disability. They achieved this through the content of each item in the HHQ and by carefully timing the administration of the HHQ and SSQ. The HHQ items pose questions that do not require a certain listening environment or ability in order to respond. The HHQ is recommended to be completed independently by completion of the HHQ in advance of the SSQ.

The HHQ is comprised of 12 items. Each item is scored by one of five response alternatives: never, rarely, sometimes, often and almost always. The scores are then averaged to determine an individual's global handicap score and scaled. The scale has a range of 0 to 100 where a higher score corresponds to a greater experience of handicap. Gatehouse and Noble (2004) reported a good correlation of $r = -0.61$ between the average total SSQ and handicap score. Their study population consisted of 153 adults (80 females and 73 males) with hearing impairment and no hearing aids.

1.7.5 Versions

There are three versions of the SSQ: the original version (Gatehouse & Noble, 2004), the benefit version (SSQ-B) (Jensen, Akeroyd, Noble, & Naylor, 2009) intended for first time users of hearing aids, and the comparison version (SSQ-C) (Jensen et al., 2009; The Medical Research Council Institute of Hearing Research) used to compare two different sets of hearing aids. The latter two are able to be used with any form of intervention such as hearing aids, cochlear implants and communication training (The Medical Research Council Institute of Hearing Research). All three versions are available in English, Danish, Dutch, German and Swedish. Additionally, the original version is available in Korean (Heo, Lee, & Lee, 2013).

There are several abbreviated versions of the SSQ, for example, Speech, Spatial and Qualities of Hearing Scale 15 item short form (SSQ15) (Kiessling, Grugel, Meister, & Meis, 2011), Speech, Spatial and Qualities of Hearing Scale 5 item short form (SSQ5) (Demeester et al., 2012), and SSQ12 (Noble et al., 2013). Kiessling et al. (2011) formed the SSQ15 for use in their studies of binaural hearing. The SSQ5, by Demeester et al. (2012), is a 5 item screening measure of hearing disability that has been statistically optimised for high sensitivity and specificity. The SSQ12 developed by Noble et al. (2013) is representative of the original SSQ. It is also available in 3 versions (original, benefit (SSQ12-B), and comparison (SSQ12-C) and in English, Danish, and Swedish (The Medical Research Council Institute of Hearing Research). My review of the literature has revealed that there are currently no test re-test reliability scores available for these versions.

Karyn L Galvin and Noble (2013) developed versions of the SSQ that were adapted for paediatric use. These include the SSQ for Teachers, SSQ for Parents and the SSQ for Children. Each adaptation has a differing number of questions for each subscale and age appropriate wording dependent on the intended respondent.

1.7.6 Research

The SSQ has been used in many studies for various purposes. Studies focussed on the use of cochlear implants include: Karyn Louise Galvin, Mok, and Dowell (2007) who modified the SSQ for use as a comparison measure of unilateral versus bilateral cochlear implants for children, and teachers and parents of those children; Laske et al. (2009) used the SSQ to observe self-report outcomes following varying intervals of bilateral cochlear implantation; Fuller, Free, Maat, and Başkent (2012) examined the association between musical training and cochlear implant performance; and Hua, Johansson, Jönsson, and Magnusson (2012) used the SSQ to evaluate different conditions in adults with unilateral cochlear implants and linear frequency transposing hearing aids.

Other studies utilising the SSQ include: Banh et al. (2012) who compared responses given in the SSQ between younger and older adults of normal hearing; Noble and Gatehouse (2004) compared the SSQ responses across two categories of adults with hearing impairment, those with symmetrical impairment and those with asymmetrical impairment; Olsen, Hernvig, and Nielsen (2012) used the SSQ to compare the performance of adults with unilateral sensorineural hearing impairment and those of normal hearing; Singh and Pichora-Fuller (2010) examined the test re-test reliability of the SSQ across a range of administration methods; and Akeroyd et al. (2014) conducted a factor analysis on the SSQ.

1.7.7 Psychometric Properties

1.7.7.1 Reliability.

The test re-test reliability of the SSQ when administered to 159 older adults (mean age = 72.8 years, SD = 5.6) was reported on by Singh and Pichora-Fuller (2010). The SSQ was administered at two time points (an interval of 6 months) for each of the administration methods: interview with a trained professional and self-administered using mail. The test re-test correlations were found to be highest through the interview administration method with a correlation of $r = 0.83$ at both test times. A lower correlation of $r = 0.65$ was reported through the self-administration method. They also reported a Cronbach's alpha value of 0.96-0.97 for the interview methods and 0.88-0.93 for the mail methods. Singh and Pichora-Fuller (2010) concluded that 1) the method of administration does not play a significant role in the SSQ scores of older adults with normal to mild hearing impairments; and 2) the SSQ could play a role in identifying communication difficulties the cannot be ascertained from the audiogram.

1.7.7.2 Validity.

A factor analysis of the SSQ scores of 1220 participants was performed by Akeroyd et al. (2014). Across the three participant groupings investigated (unaided, unilaterally aided, bilaterally aided), it was found that the three factors existed: speech understanding; spatial perception; and clarity, separation, and identification. Effort and concentration was suggested as a potential fourth factor. Each of the three factors were linked to a subscale within the SSQ. Based on the factor loadings, a visible relationship exists between the SSQ items and what they purport to measure. This suggests a congruous level of construct validity of the SSQ.

Moulin et al. (2015) completed a factor analysis on the SSQ in multiple languages, different administration methods, and on a different population to that of Akeroyd et al. (2014). They reported close reproducibility between their results and those of Akeroyd et al. (2014) which supports the validity of the SSQ.

1.8 Speech, Spatial and Qualities of Hearing Scale 12 item short form

1.8.1 Purpose

Noble et al. (2013) were prompted to develop the SSQ12 as the shortened adaptations currently available are not suitable for routine clinical use. They are not able to fully measure the disability in hearing speech, spatial hearing and quality of hearing experience the 49 item SSQ is intended to measure (Gatehouse & Noble, 2004). Additionally, routine clinical use is difficult to achieve with the parent 49 item SSQ as the length of the questionnaire works against its practicality in a clinical environment where time is limited. Thereby, being a 12 item questionnaire, the administration time is decreased which increases its potential for routine clinical use (Noble et al., 2013).

The SSQ12 was designed by Noble et al (2013) with the purpose of being an efficient measure of clinical hearing impairment intervention, when used in conjunction with the HHQ (Noble et al., 2013). This scaled down version is intended to be more efficient for clinical use as a measure of pre and post hearing impairment clinical intervention measure (Noble et al., 2013). When used as a pre and post measure of intervention the clinician would be able to gauge the levels of disability and impairment of the client prior to intervention and identify areas of improvement (Noble et al., 2013).

1.8.2 Development

The SSQ12 was developed to be a suitable assessment of intervention efficacy, represent the 49 item SSQ as a whole and to be used in conjunction with the HHQ (Noble et al., 2013). The 12 item length of the questionnaire was influenced in part by the HHQ, which also consists of 12 items. Another influence, was the ability to compare the 10 pragmatic subscales, developed by Gatehouse and Akeroyd (2006), and the SSQ12. The subscales consist of speech in quiet, speech in noise, speech in speech contexts, multiple speech stream processing and switching, localisation, distance and movement, sound quality and naturalness, identification of sound and objects, segregation of sounds, and listening effort (Gatehouse & Akeroyd, 2006). An additional impact on the development of the SSQ12 was the factor analysis of the SSQ by Akeroyd et al. (2014). The outcome of this factor analysis was used to form a comparison between the SSQ and SSQ12 (Noble et al., 2013).

Three centres: Eriksholm Research Centre (ERC), MRC Institute of Hearing Research Scottish Section (MRC) and University of New England (UNE) had input in the selection of items for the SSQ12. Each centre was asked to nominate 12 items based on their experience and the perceived impact these items would have in a clinical environment. The nominations produced by ERC did not include items that were considered not applicable by a significant number of respondents. Preference was placed on items included in other SSQ short forms and those that were answered with a wide range of scores. They also took into consideration the pragmatic subscales (Gatehouse & Akeroyd, 2006), and the results of the factor analysis (Akeroyd et al., 2014).

MRC based their nominations on the secondary factor analysis and favoured those items with better readability (Noble et al., 2013). In total 9 items were chosen to represent each of the factor loadings: speech, spatial and other qualities (Akeroyd et al., 2014). Speech items were representative of situations requiring speech to be heard in amongst competing sounds. Spatial items were demonstrative of non-speech sounds heard at a distance or while moving laterally, and towards or away from the listener. Finally, items in the qualities category were a reflection of the listener's ability to hear clearly, separate sounds and identify sounds. The remainder of the items were chosen independent of the factor analysis. Items descriptive of telephone conversations, externalisation and the effort required to listen were chosen for their perceived importance based on MRC's experience (Noble et al., 2013).

UNE nominated items representative of the initial factor analysis which provided four factor loads (Noble et al., 2013). Other influences on their decision included the contribution of multi stream speech perception, directional location, applicability across different communities, and the items' sensitivity range to unilateral and bilateral amplification based on information from the SSQ (Gatehouse & Noble, 2004; Noble et al., 2013).

Ten items were nominated by at least two centres. Noble et al. (2013) selected two (3 and 7) of the three items nominated by all the centres. The third common item was substituted for an alternate more general form of the question (12). Items nominated by two centres were included in the SSQ12 these items are: 1, 5, 6, 8, 9. Item 10 was included to incorporate the ability to separate simultaneous sounds. Items 2 and 4 were selected to represent items nominated by single centres if other questions did not cover their intended purpose. As a result, 12 items formed the SSQ12. A full list of items has been defined (see Table 2). It is representative of nine out of the ten pragmatic subscales and of the three subscales determined by factor analyses (Noble et al., 2013).

Table 2

Items included in the SSQ12.

SSQ12 item number	**Item**
1	You are talking with one other person and there is a TV on in the same room. Without turning the TV down, can you follow what the person you're talking to says?
2	You are listening to someone talking to you, while at the same time trying to follow the news on TV. Can you follow what both people are saying?
3	You are in conversation with one person in a room where there are many other people talking. Can you follow what the person you are talking to is saying?
4	You are in a group of about five people in a busy restaurant. You can see everyone else in the group. Can you follow the conversation?

5	You are with a group and the conversation switches from one person to another. Can you easily follow the conversation without missing the start of what each new speaker is saying?
6	You are outside. A dog barks loudly. Can you tell immediately where it is, without having to look?
7	Can you tell how far away a bus or a truck is, from the sound?
8	Can you tell from the sound whether a bus of truck is coming towards you or going away?
9	When you hear more than one sound at a time, do you have the impression that it seems like a single jumbled sound?
10	When you listen to music, can you make out which instruments are playing?
11	Do every day sounds that you can hear easily seem clear to you (not blurred)?
12	Do you have to concentrate very much when listening to someone or something?

Notes. Adapted from "A short from of the Speech, Spatial and Qualities of Hearing Scale suitable for clinical use: The SSQ12",by Noble et al. (2013)

Reliability of the SSQ12

1.8.3 Psychometric Properties

1.8.3.1 Validity.

Noble et al. (2013) analysed the relationship between scores obtained on the SSQ and the SSQ12. They found the scores to be within close agreement, although, the average scores on the SSQ12 were found to be slightly lower than that of those obtained on the SSQ (Noble et al., 2013). This was also observed in Moulin and Richard (2016). Noble et al. (2013) also reported that the SSQ12 exhibits greater sensitivity to changes in hearing ability than the SSQ. This greater sensitivity was shown by the steeper slope obtained using a power function. The steeper slope indicated a larger difference between high and low scores obtained on the SSQ12 compared to the SSQ (Noble et al., 2013).

Moulin and Richard (2016) also utilised power functions to report on the correlation between the SSQ12 and SSQ scores. A high correlation with a large effect size ($r^2 = 0.96$) was also found. Both studies indicate the validity of the SSQ12.

1.8.3.2 Reliability.

To date, there has been no research on the reliability of the SSQ12.

1.9 Research Rationale and Aims

Hearing impairment can result in a decreased quality of life for individuals due to hearing related disabilities and handicaps (Killion et al., 2004; Mulrow, Aguilar, Endicott, Velez, et al., 1990). While there are intervention methods aimed at targeting hearing function, objective measures alone are not an accurate predictor of benefit (Cox, 2003; Mendel, 2007). There are many self-report measures available for clinical use, however, they do not comprehensively cover challenging listening situations, which individuals with hearing impairment find most difficult (Gatehouse & Noble, 2004). The SSQ is a comprehensive assessment; however, its feasibility for clinical use is challenged due to its length. This increases the administration time, where a time pressure already exists (Noble et al., 2013). The SSQ12 is an abbreviated and representative form of the SSQ intended for clinical use. However, in order to widely use an assessment such as the SSQ12, its reliability must be determined. Therefore, one purpose of my research is to determine the reliability (stability) of the SSQ12 amongst individuals with hearing impairment and no hearing aids.

Previous research by Demeester et al. (2012) and Noble and Gatehouse (2004), suggest that age and hearing asymmetry may play a role in the scores obtained in the SSQ. As the SSQ12 is representative of the SSQ, the second purpose of this study is to investigate if a pattern exists in SSQ12 scores based on measured factors: age, gender, the degree of hearing impairment, income, ethnicity, HHQ score.

1.10 Research Questions and Hypotheses

The questions being addressed by this study are:

1. Is the overall SSQ12 reliable when administered to individuals with hearing impairment and no hearing aids at allocated time points?
2. Are the scores obtained in each SSQ12 subscale reliable when administered to individuals with hearing impairment and no hearing aids at allocated time points?
3. Does a pattern exist between the responses given and the measured factors?

Following a review of the literature the hypotheses are:

1. The overall SSQ12 score obtained at the allocated time points will remain stable.
2. The scores obtained in each section of the SSQ12 at the allocated time points will remain stable.

Reliability of the SSQ12

3. A pattern will not exist between the responses given and the measured factors.

2. Method

2.1 Ethics Approval

Ethics approval by the Human Ethics Committee at the University of Canterbury was obtained on the 5th of August 2015 (see Appendix A).

2.2 Participants

I recruited 21 participants by placing posters (see Appendix B) throughout Christchurch, New Zealand. Approximately 50 posters were placed in small businesses, health care centres and community buildings (e.g. libraries) with permission by the owner/management staff. I removed all posters once the minimum number of participants was met. Recruitment continued until 1 June 2016. Participants also spread awareness about the study and recruited other participants through word of mouth.

Any participant was accepted into the study if they met the following criteria:

(a) A hearing impairment greater than 20 dB HL in at least one ear.

(b) Never worn hearing aids prior to and for the duration of the study.

(c) Eighteen years of age or older.

(d) Have sufficient competency in the English language to be able to complete all questionnaires involved in the study as determined by the individual and myself.

(e) Be available and willing to complete the three questionnaires at 6 week intervals.

(f) Participants were not offered inducements for partaking in the study.

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2.2.1 A *Priori* Analysis

I determined the minimum sample size required for a repeated measures ANOVA analysis by completing a *priori* analysis on the G*Power 3.1 software. The input parameters were an effect size of 0.50, an alpha error probability of 0.05, a power of 0.80 and two tailed. A minimum sample size of 10 participants was needed to perform the planned analyses.

I also determined the minimum sample size required for a correlation analysis by completing a *priori* analysis using the same software. The input parameters were an effect size of 0.50, an alpha error probability of 0.05, a power of 0.80 and two tailed. A minimum sample size of 11 participants was needed to perform the analyses.

2.3 Materials

All SSQ12 questionnaires, demographic information sheets, and HHQ were completed via pen and paper administration (see Appendix C). The SSQ12 designed by Noble et al. (2013) was the questionnaire used in the study.

The scoring scheme was consistent for all 12 items. Each item was scored using a visual analogue scale where the left hand end represented complete inability or a complete absence of effort “not-at-all” were given a numerical value of 0. The right hand end represented complete ability or maximum effort “perfectly” and were give a numerical score of 10.

I determined the scoring for each item based on markings e.g. circling a number made on the scale by the participants. For those items where only one number was marked on the scale e.g. 7 this was the score used (see Figure 1). For other items where a range of numbers were marked on the scale e.g. 7-8 a halfway value between the two numbers e.g. 7.5 was used as the score (see Figure 2). Therefore, in order to determine scoring reliability random hard copies from each of the time points (T0, T1 and T2) were selected to be scored by another marker.

Figure 1

Example of scoring a 7 on the visual analogue scale.

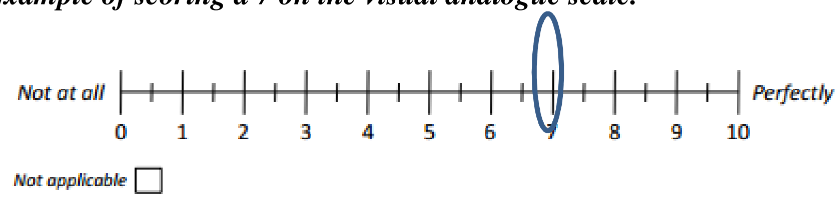
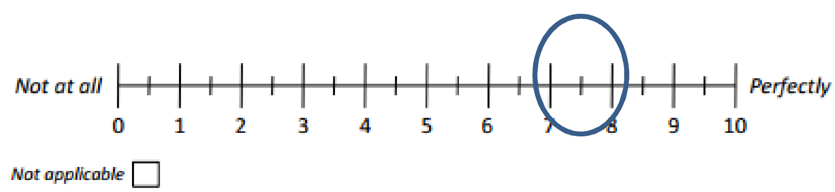


Figure 2

Example of scoring a 7.5 on the visual analogue scale.



2.4 Procedure

All participants without a recent hearing test (within the last year) underwent a hearing test at the University of Canterbury (UC) or in a private home. At UC, testing was conducted in a sound treated booth and met the standards enforced by the American National Standards Institute (1999) S3.1-1999. The testing equipment used included the GSI 61 clinical audiometer that was calibrated for 22 June 2017 and Telephonics TDH-50P supra aural headphones. In the private home, testing was conducted using a calibrated Maico MA 41 with Peltor HA 7A sound attenuating earphones in a quiet room meeting the ANSI 1999 standard for ambient noise when testing by air conduction.

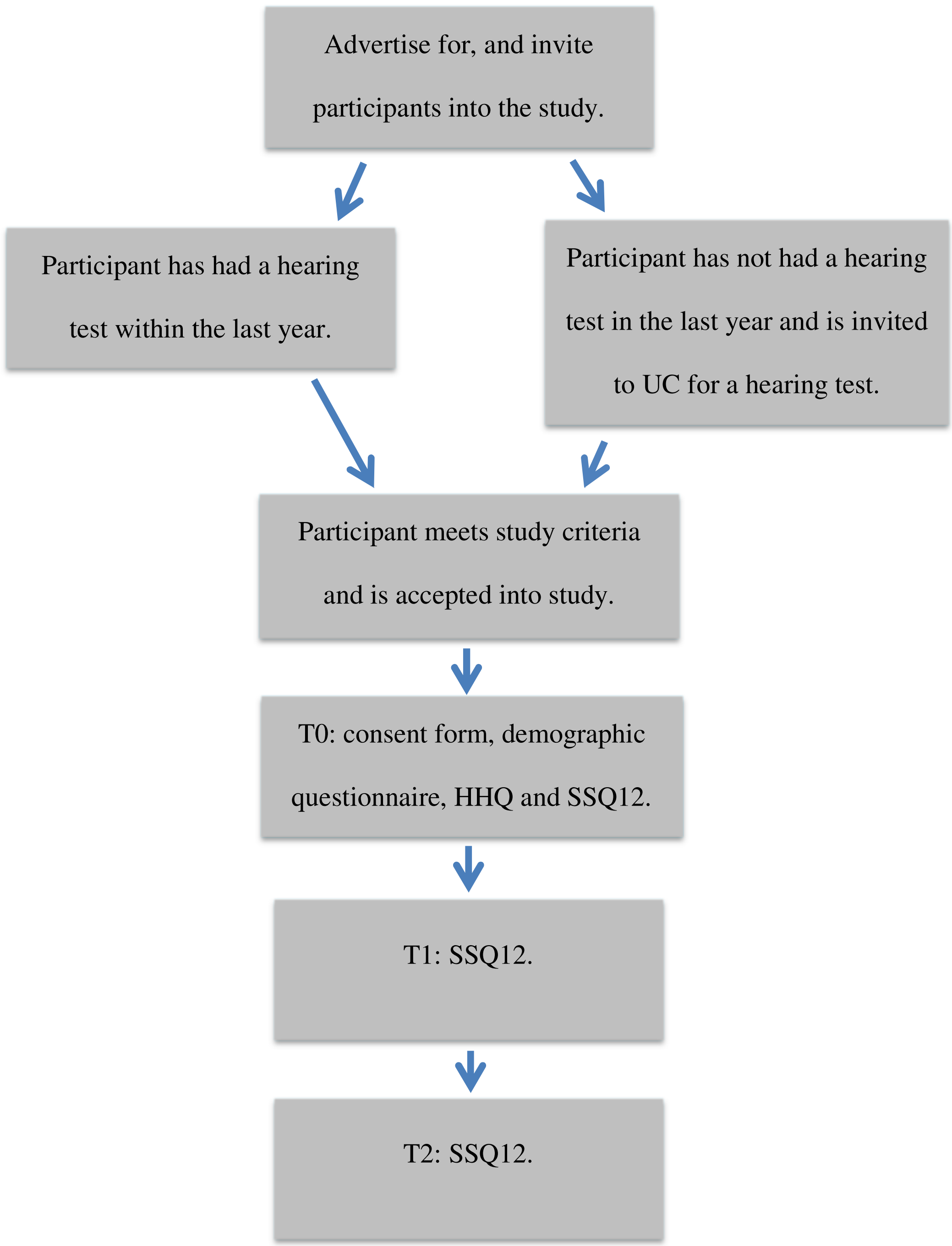
Prior to testing, otoscopy was performed to ensure the ears were suitable for testing. Puretone air conduction thresholds were obtained at the frequencies: 250, 500, 1000, 2000, 4000, and 8000 Hz using the modified Hughson Westlake procedure (University of Canterbury Speech and Hearing Clinic, 2015). Interoctave frequencies were not tested unless otherwise indicated i.e. equal to or greater than 20 dB difference between octaves (University of Canterbury Speech and Hearing Clinic, 2015).

Once a hearing impairment was established, the participants were provided an envelope with the initial set of questionnaires, this point was considered the first administration at week 0 (T0). The envelope included the consent form, demographic questionnaire, HHQ and SSQ12. After the participant had completed and returned the questionnaires, I calculated the second administration at week 6 (T1). T1 is the date 6 weeks after T0 and when the next SSQ12 would need to be sent by and completed. This was repeated for T1 to calculate the date for the third administration at week 12 (T2) (see Figure 3).

Participants were made aware of the preferred date for completion at time points T1 and T2 with a note that was included within the mailed envelope (see Figure 3).

Figure 3

Flow chart of mailing procedure.



Notes. Abbreviations defined as: Hearing Handicap Questionnaire (HHQ), Speech, Spatial and Qualities Questionnaire (SSQ12), University of Canterbury (UC), first administration at week 0 (T0), second administration at week 6 (T1) and third administration at week 12 (T2).

2.5 Planned Analyses

The statistical analyses expected to be completed are: descriptive statistics, mixed measures ANOVA, and Pearson's correlations. The descriptive statistics would determine the mean, standard deviation, and the maximum and minimum of the participants' age, severity, BEPTA, WEPTA and HHQ average (HHQ Avg). The mixed measures ANOVA would determine the stability of the total, speech, spatial and qualities scores over the three administration time points T0, T1 and T2. Pearson's correlations would determine the presence of significant relationships between age, severity, BEPTA, WEPTA and HHQ Avg; and the total, speech, spatial and qualities scores over the three administration time points T0, T1, and T2.

3. Results

3.1 Participants

In total, 23 participants met the study's inclusion criteria and were invited to take part. One participant dropped out due to unknown reasons; their data was not included in any statistical analyses. Analyses on the data set for skewness and kurtosis revealed abnormal distribution for all scores obtained at all time points. There were outliers present in the data set; therefore, instead of the planned analyses, non-parametric measures were used for all further analyses.

The data set consisted of 11 females and 11 males with a mean age of 67.00 years. Further descriptive statistics for participant age, severity of hearing impairment, BEPTA, WEPTA and HHQ Avg were calculated (see Table 3).

Spearman's rho correlations were performed in order to determine the relationship between age, severity, BEPTA, WEPTA, and HHQ Avg. There were significant positive correlations between age and BEPTA; age and WEPTA; and BEPTA and WEPTA (see Table 4).

Table 3

The descriptive statistics (minimum, maximum, mean and standard deviation) for all the participants.

Variable	Minimum	Maximum	Mean	Standard Deviation
Age	29.00	79.00	67.41	10.94
Severity	2.00	7.00	4.80	1.076
BEPTA	1.25	66.25	39.15	15.39
WEPTA	21.25	70.00	45.17	12.66
HHQ Avg	1.75	4.33	2.54	0.53

Notes. The abbreviations are defined as better ear puretone average (BEPTA), worse ear puretone average (WEPTA), and Hearing Handicap Questionnaire average (HHQ Avg).

Table 4

Spearman's rho correlations for age, severity, better ear puretone average (BEPTA), worse ear puretone average (WEPTA), and Hearing Handicap Questionnaire average (HHQ Avg).

Variable	Severity	BEPTA	WEPTA	HHQ Avg
Age	0.048	0.766*	0.676*	0.106
Severity		0.174	0.027	-0.030
BEPTA			0.853*	0.124
WEPTA				-0.077

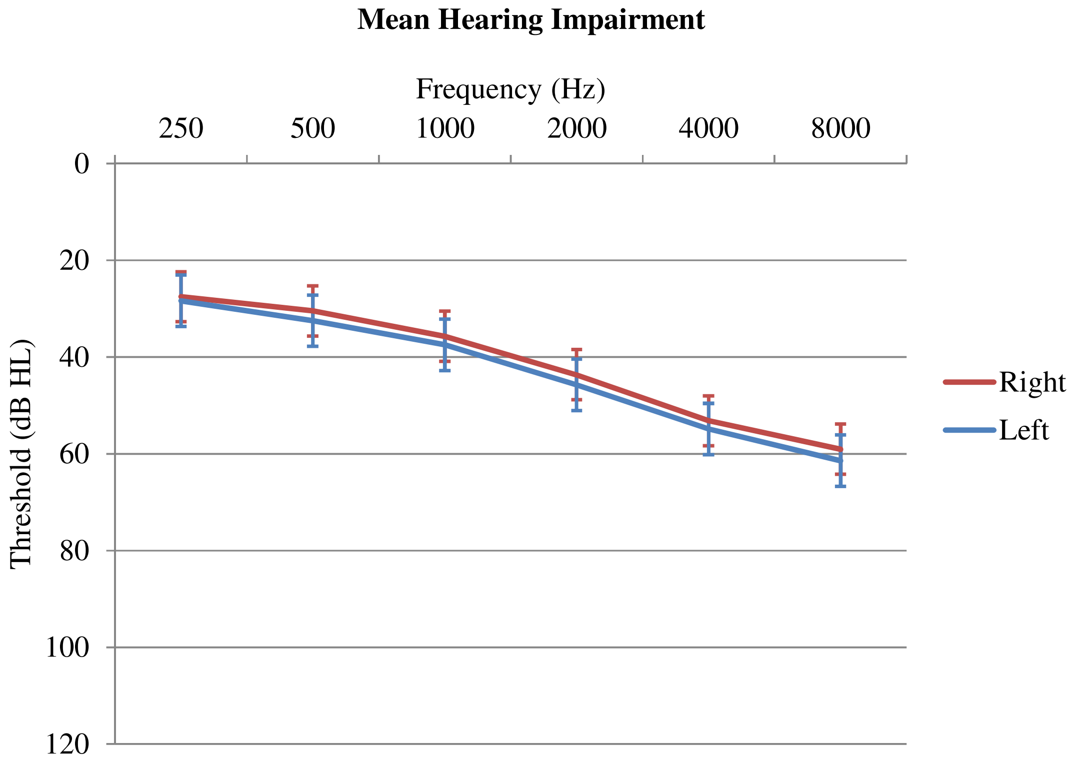
Notes. Asterisk (*) indicates correlation is significant at the $p < 0.01$ level (2-tailed).

Reliability of the SSQ12

There was no significant (≥ 15 dB HL) asymmetry between the left and right ear based on the average hearing impairment amongst participants (see Figure 4). Both ears showed a mild loss at the low frequencies sloping to a moderately-severe loss at the higher frequencies.

Figure 4

Audiogram of mean hearing impairment across the tested frequencies for both ears with standard error bars for each ear.



Reliability of the SSQ12

Large proportions of the participants were New Zealand European (91%); had an income of less than 50k (81.9%); and were in a relationship (72.7%) at the time of the study. Further information about the distribution of participants across the demographic information ethnicity, income, relationship and education was calculated (see Table 5).

Table 5

Participant distribution across demographic categories.

	Ethnicity		**Income**		**Relationship**		**Education**	
Distribution (%)	NZE	91	NA	4.5	No	27.3	< High school	18.2
	Dutch	4.5	< 50k	81.9	Yes	72.7	High school	31.8
	Chinese	4.5	> 50k	13.6			Tertiary	36.4
							Postgraduate	13.6

Notes. Abbreviations are defined as New Zealand European (NZE) and not applicable (NA).

3.2 Research Question One and Two

These research questions examined the reliability of the SSQ12 and the three subscales over the three allocated time points (T0, T1, and T2). To evaluate the test re-test reliability Friedman's tests were conducted. The variables were the scores obtained for each time point for the categories total, speech, spatial and qualities.

There were no significant differences across all categories scores across the three time points: total (χ^2 (2) = 0.127, p = 0.938), speech (χ^2 (2) = 1.677, p = 0.432), spatial (χ^2 (2) = 5.719, p = 0.057), and qualities (χ^2 (2) = 0.915, p = 0.633). The descriptive statistics for each subscale for each time point was calculated (see Table 6).

Table 6

Descriptive statistics range and median for mean total and subscale scores across the three administration time points: T0, T1 and T2.

Time point	Subscale	Range	Median
T0	Total	3.42-8.58	6.44
	Speech	1.20-8.00	5.70
	Spatial	0.00-10.00	7.25
	Qualities	5.25-9.75	6.75
T1	Total	2.75-8.33	6.46
	Speech	0.60-8.20	5.80
	Spatial	3.33-9.83	7.17
	Qualities	2.75-8.75	6.69
T2	Total	3.17-7.83	6.46
	Speech	3.20-8.00	6.00
	Spatial	3.33-9.92	7.09
	Qualities	3.00-8.63	6.69

Notes. Abbreviations are defined as: first administration at week 0 (T0), second administration at week 6 (T1), and third administration at week 12 (T2).

Reliability of the SSQ12

Spearman's rho correlations were performed for each the mean total and subscale scores over the three time points. Significant positive correlations were observed for all total and subscale mean scores over the allocated time points (see Table 7).

Table 7

Spearman's rho correlations for mean total and subscale scores across the administration time points: T0, T1, and T2.

	Total	**Speech**	**Spatial**	**Qualities**
T0-T1	0.937*	0.920*	0.888*	0.922*
T1-T2	0.902*	0.933*	0.888*	0.872*
T0-T2	0.819*	0.880*	0.699*	0.851*

Notes. Abbreviations are defined as: first administration at week 0 (T0), second administration at week 6 (T1), and third administration at week 12 (T2). Statistical significance of the correlations at $p < 0.05$ is indicated by the asterisk (*).

Reliability of the SSQ12

The lower and upper limits of the confidence intervals as well as the critical difference for total and subscales for each of the different time points were calculated (see Table 8).

Table 8

Range of 95% confidence intervals (CI) and critical differences for mean total and subscale scores across administration time points T0, T1 and T2.

		Lower and upper limit of 95% CI	**Critical difference**
Total	T0-T1	-0.1707 – 0.0307	0.2013
	T1-T2	-0.1524 – 0.1524	0.3049
	T0-T2	-0.3592 – 0.2192	0.5784
Speech	T0-T1	-0.211 – 0.151	0.362
	T1-T2	0.0284 – 0.3316	0.3032
	T0-T2	-0.1215 – 0.4215	0.543
Spatial	T0-T1	-0.2254 – 0.3854	0.6108
	T1-T2	-0.3406 – 0.1006	0.4412
	T0-T2	-0.8061 – 0.7261	1.5322
Qualities	T0-T1	-0.3657 - -0.1143	0.2515
	T1-T2	-0.3563 – 0.0563	0.4127
	T0-T2	-0.6302 - -0.1498	0.4804

Notes. Abbreviations are defined as: first administration at week 0 (T0), second administration at week 6 (T1), and third administration at week 12 (T2).

Reliability of the SSQ12

3.3 Research Question Three

The third research question examined any patterns that may exist between the scores for each of the subscales at the allocated time points and the continuous variables: age, severity, BEPTA, WEPTA and HHQ Avg. In order to evaluate this Spearman's rho correlations were performed (see Table 9). Significant negative correlations were found between T0 total, speech, qualities and HHQ Avg; T1 total, speech and HHQ Avg; and T2 speech and HHQ Avg. A significant positive correlation was observed between T2 spatial and severity.

Table 9

Spearman's rho correlations for mean total and subscale scores across T0, T1, T2 and the continuous variables.

		Age	Severity	BEPTA	WEPTA	HHQ Avg
T0	Total	-0.156	-0.021	-0.137	0.023	-0.630**
	Speech	-0.064	-0.051	-0.015	0.138	-0.652**
	Spatial	0.061	0.173	0.046	-0.116	-0.256
	Qualities	-0.186	-0.107	-0.195	0.036	-0.440*
T1	Total	0.034	-0.073	-0.033	0.091	-0.554**
	Speech	-0.044	-0.134	-0.082	0.097	-0.588**
	Spatial	0.153	0.247	0.127	-0.020	-0.099
	Qualities	-0.058	-0.006	-0.066	0.080	-0.301
T2	Total	0.085	-0.044	0.028	0.191	-0.377
	Speech	0.028	-0.148	0.034	0.203	-0.449*
	Spatial	0.047	0.460*	0.131	0.049	-0.017
	Qualities	-0.007	-0.109	-0.068	0.190	-0.348

Notes. Abbreviations defined as better ear puretone average (BEPTA), worse ear puretone average (WEPTA), and Hearing Handicap Questionnaire average (HHQ Avg). Statistical significance is indicated by the asterisk (*) at the $p < 0.05$ level and asterisks (**) at the $p < 0.01$ level.

4. Discussion

4.1 Research Question One and Two

4.1.1 Hypotheses

The primary investigation of this thesis was focussed on the test re-test reliability of the mean SSQ12 scores across the allocated time points. This was due to the gap in the literature regarding this topic. There were two hypotheses related to this: 1) the mean total SSQ12 scores would remain stable over time, and 2) the mean SSQ12 subscale scores would remain stable over time. The hypotheses were supported by the lack of significant difference across the mean total and subscale SSQ12 scores across the time points: T0, T1 and T2, indicating the SSQ12 has good test re-test reliability.

4.1.2 Relationship to Literature

A previous investigation by Singh and Pichora-Fuller (2010), on the topic of the test re-test reliability of the SSQ, reported a statistically significant correlation of $r = 0.65$ and correlations ranging from 0.64 to 0.83 for the subscales. The correlations obtained in this study for the SSQ12 subscales and total scores were larger, with mean total score correlations ranging from 0.819 to 0.937 and subscale correlations ranging from 0.699 to 0.933.

Differences in questionnaire administration intervals may contribute to these larger correlations. Longer intervals ranging from 3-6 months are likely to result in lower test re-test relibabilty, than shorter counterparts (Demorest & DeHaven, 1993). Singh and Pichora-Fuller (2010) administered over two time points at a 6 month interval, while this study administered over shorter intervals of 6 weeks at three time points. The differences in correlations observed in our study and those previous, do not make our results any less valid, as 6 week intervals are considered sufficient enough to report that memory is a minimal contributing factor to high correlation scores (Demorest & DeHaven, 1993).

The interval length may also account for the decreased correlations found between the SSQ12 subscales and total scores for time points T0 and T2. The 12 weeks interval resulted in lower correlations compared to those observed between the SSQ12 subscales and total scores for time points T0 and T1, particularly for the spatial subscale (0.699).

4.2 Research Question Three

4.2.1 Hypothesis

The final question posed was if a pattern existed between the responses given at each administration and the measured factors: age, severity, BEPTA, WEPTA, and HHQ Avg. I hypothesised that a pattern would not exist between the responses given and the measured factors. This was negated by the significant correlations found between T0 total, speech, qualities and HHQ Avg; T1 total, speech and HHQ Avg; and T2 speech and HHQ Avg; and T2 spatial and severity.

4.2.2 Relationship to Literature

To the best of my knowledge, there is currently no published literature detailing significant relationships between SSQ12 performance with age, BEPTA, WEPTA, severity, and HHQ Avg. The findings of this study will be compared to the available SSQ literature as there have been investigations into these relationships for the SSQ.

Reliability of the SSQ12

4.2.2.1 Hearing Impairment and Asymmetry.

Previous investigation by Singh and Pichora-Fuller (2010) found no significant relationship between audiometric thresholds with SSQ performance at any time point. This is in line with the findings of this study for SSQ12 performance at all time points in relation to BEPTA and WEPTA. However, other studies have reported significant correlations between SSQ performance and hearing impairment.

A significant correlation between audiometric thresholds and SSQ performance was reported by Gatehouse and Noble (2004). They found a significant correlation between a majority of SSQ items and BEPTA. The differences in the findings of this study from Gatehouse and Noble (2004) may be due to differences in BEPTA and WEPTA between the two studies. The BEPTA was similar at 39.15 dB HL for this study and 38.8 dB HL for Gatehouse and Noble (2004), however, the WEPTA was 45.17 dB HL and 52.7 dB HL, respectively.

Banh et al. (2012) found the group with unilateral sensorineural hearing impairment rated themselves lower across all SSQ subscales than their reference group counterparts. While their study did not investigate the relationship between BEPTA, WEPTA and SSQ scores, it does suggest a unilateral hearing impairment impacts SSQ performance. Both Noble and Gatehouse (2004) and Moulin and Richard (2016) investigated hearing impairment asymmetry and reported its significant effect of SSQ total scores, particularly for the spatial subscale. As this study did not address hearing impairment asymmetry, the performance on the SSQ12 in relation to unilateral hearing impairment and the relationship between SSQ12 performance, BEPTA and WEPTA may be an area future studies wish to investigate.

4.2.2.2 Handicap.

Gatehouse and Noble (2004) reported significant ($p < 0.01$) negative correlations for the SSQ items in association with handicap, as determined by the HHQ. Significant ($p < 0.01$ and $p < 0.05$) negative correlations were found in this study for the average total score for time points T2 and T1. In addition, unlike Gatehouse and Noble (2004) who reported that no one subscale showed greater association, the findings of this study report speech to dominate in its association to handicap across all subscales. It is unclear as to the reason behind this difference. This may be partly due to audiometric thresholds not acting as an accurate indicator of handicap. There may be other factors, not included in this study, such a cognitive state influencing the relationship between the experienced handicap and the reported disability (Demorest & Walden, 1984; Kielinen & Nerbonne, 1990).

4.2.2.3 Age.

In contrast to the findings of Banh et al. (2012) and Moulin and Richard (2016) on the effect of age on SSQ response, this study did not find a significant correlation between SSQ12 response and age. Banh et al. (2012) and Moulin and Richard (2016) recruited participants with normal, near normal, and impaired hearing and separated the participants into groups based on age. It may be that the difference in findings between this study and theirs is likely due to the limited representation of younger adults in my study sample. Noble and Gatehouse (2004), who reported no significant correlation between SSQ response and age, also had no younger or older participant groupings. Further investigation into age effects on SSQ12 performance would be important for clinical use. This is because knowing the optimal scores that could be expected from each age group could help the audiologist set realistic goals for intervention for each age group (Banh et al., 2012).

Reliability of the SSQ12

4.3 Clinical Implications

Bernstein (1994) recommended any questionnaire intended for clinical use meet the minimum test re-test reliability correlations of 0.8. Many self-report questionnaires used in audiology meet this criteria, for example the HHIA (r = 0.97) and HHIA-S (r = 0.93) (Newman, Weinstein, Jacobson, & Hug, 1991), HHIE (r = 0.84) (Weinstein, Spitzer, & Ventry, 1986), and shortened HAPI (r = 0.8) (Schum, 1993). The SSQ12 total and a majority of the subscale score correlations met this requirement.

For audiologists wanting to measure changes in hearing related to speech, spatial and other qualities, the SSQ12 is a reliable measure. The correlations, having been based on pen and paper administration, support the suggestion, by Gatehouse and Noble (2004), for the completion of the SSQ12 prior to the appointment. This would not only allow for greater understanding of the client's difficulties but also bypass the time restrictions of the appointment.

In order to effectively utilise the SSQ12 in a clinical setting, the audiologist should be aware of two things. First, when interpreting scores obtained in the SSQ12 as a measure of intervention, it is necessary to refer to the critical differences in Table 8. This is due to the varying critical difference values ranging from 0.2013 to 1.5322 for the total and subscale scores. This is important as the critical difference indicates changes in the SSQ12 can be interpreted as a true difference with 95% confidence (Demorest & Walden, 1984). Second, the correlations in Table 7 show that the timing of assessments is important. The highest correlations (> 0.80) were between T0 and T1, and T1 and T2. These strong correlations were not continued between T0 and T2, particularly for the spatial subscale. This shows that timing of administration is important when trying to observe effect of intervention. Based on this the recommendation would be to shorten the time frame between administrations to around 6 weeks.

An additional use of the SSQ12 could include as a questionnaire in clinic related studies. The SSQ has been used in previous studies by Karyn Louise Galvin et al. (2007), Hua et al. (2012), and Laske et al. (2009) to compare various intervention conditions. As the SSQ12 has been shown to have greater sensitivity than the SSQ by Noble et al. (2013) and this study has shown its reliability it is a viable questionnaire option for future studies.

4.4 Research Limitations and Directions for Future Research

Participant self-selection was one of the first limitations of this study. All participants were recruited on a voluntary basis as long as they met the criteria for the study. This introduced a form of bias as these volunteers may portray characteristics that are not a true reflection of all individuals with hearing impairment. As a result, the findings of this study should be interpreted with caution when used to portray this population. In addition, there may be more variables that impact the reliability questionnaire than we have accounted for in our demographic questionnaire and HHQ. Further studies could investigate other variables that may impact the reliability of the SSQ12.

Due to difficulties in recruitment there was a small sample size of 21 participants. A large proportion of these participants were New Zealand Europeans. It would be useful in further research to include a larger sample size and continue administration across different countries. This would increase the generalisability of any test re-test reliability findings.

Important areas that need to be addressed in future research, aside from those previously mentioned, include the 1) test re-test reliability for individuals with hearing impairment who wear hearing aids. This would aid in ascertaining normative values and the difference in scoring expected with hearing aid use in relation to their handicap score. 2) Test re-test reliability of the SSQ12 for individuals with hearing impairment who do not wear hearing aids and those with hearing aids when administered by interview. Test re-test reliability has been shown to be larger when self-report questionnaires are administered by the interview method. This has been shown in many self-report measures including the SSQ (Singh & Pichora-Fuller, 2010) and the Hearing Handicap Inventory for the Elderly (Weinstein et al., 1986). As this questionnaire has the potential to be interview administered in clinical settings, it would be important to investigate its reliability when the administration method is changed. 3) Potential factors that lead to the variability across longer administration time points. This is particularly relevant to the spatial subscale of the SSQ12 as the correlation was the weakest.

4.5 Conclusion

It is important to address the reliability of a self-report questionnaire before it is used clinically, as it is important to know any measured changes are due to treatment and not day to day fluctuations. This study aimed to address a gap in the literature by investigating the test re-test reliability of the SSQ12 and any correlations between the measured variables and scores reported. These topics were addressed through non-parametric statistical analyses of SSQ12s administered to 21 participants at three time points (T0, T1, and T2). Results showed that the reliability of the SSQ12 is well above the clinical criteria for reliability. Relationships were found between handicap and the disability scores, as measured by the SSQ12. Furthermore, critical difference scores were calculated to aid clinicians in determining significant changes in the SSQ12 in a clinical setting.

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Appendix A

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2015/85

5 August 2015

Rebecca Kelly-Campbell
Department of Communication Disorders
UNIVERSITY OF CANTERBURY

Dear Rebecca

The Human Ethics Committee advises that your research proposal "Test-retest reliability of the speech, spatial and qualities of hearing scale - short form (SSQ12): comparison of administration method and hearing aid experience" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 4 August 2015.

Best wishes for your project.

Yours sincerely

Lindsey MacDonald
Chair
University of Canterbury Human Ethics Committee

Appendix B

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

You need to be:

Adult aged 18 years or older who:

- ✓ Has hearing loss
- ✓ Is of any age or gender
- ✓ Has never worn hearing aids before

You will:

- ✓ Fill in surveys 3 times over 12 weeks
- ✓ Provide a copy of your hearing test

If you don't have one, we will test your hearing at no cost to you.

ARE YOU AN ADULT WITH HEARING LOSS?

We need your help!

One of the most common problems people with hearing loss have is trouble understanding speech in difficult situations (like noise). A new survey was developed to measure people's experiences in those situations. This study aims to test the reliability of that survey to make sure it is useful in a clinical setting.

To take part in this research or for more information, please contact:

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Appendix C

Participant Information

Please answer each question honestly and to the best of your ability

Date: ______________________ Current age: ______________ Gender: _________________________

1. What ethnic group do you belong to?

   ☐ New Zealand European ☐ Tongan
   ☐ Maori ☐ Niuean
   ☐ Samoan ☐ Chinese
   ☐ Cook Island Maori ☐ Indian
   ☐ Other, such as Dutch, Japanese, Tokelauan. Please state: ___________________________

2. What is your relationship status? (please tick one box)

   ☐ Single ☐ Never married
   ☐ Married ☐ In a committed relationship
   ☐ Widowed ☐ Divorced
   ☐ Separated

3. What is the net annual income of your household? (please tick one box)

   ☐ $0 – $25,000 ☐ $25,000 - $50,000
   ☐ $50,000 - $75,000 ☐ $75,000 - $100,000
   ☐ more than $100,000

4. What is the highest level of education you completed? ________________________

5. On a scale of 1 to 10, how would you describe the severity of your hearing problem (1 = not at all severe, 10 = very severe)? ____________________________________

HEARING HANDICAP QUESTIONNAIRE (HHQ)

These questions ask about your experiences with hearing loss. Please circle the response that best answers the following questions.

1. How often does your hearing difficulty restrict the things you do?
never rarely sometimes often almost always

2. How often do you feel worried or anxious because of your hearing difficulty?
never rarely sometimes often almost always

3. As a result of your hearing difficulty, how often do you feel embarrassment when in the company of other people?
never rarely sometimes often almost always

4. How often is your self-confidence affected by your hearing difficulty?
never rarely sometimes often almost always

5. How often does your hearing difficulty make you feel nervous or uncomfortable?
never rarely sometimes often almost always

6. How often does any difficulty with your hearing make you feel self-conscious?
never rarely sometimes often almost always

7. How often does your difficulty with your hearing affect the way you feel about yourself?
never rarely sometimes often almost always

8. How often are you inconvenienced by your hearing difficulty?
never rarely sometimes often almost always

9. How often do you feel inclined to avoid social situations because of your hearing difficulty?
never rarely sometimes often almost always

10. How often do you feel cut off from things because of your hearing difficulty?
never rarely sometimes often almost always

11. How often does your hearing difficulty restrict your social or personal life?
never rarely sometimes often almost always

12. How often do you feel tense and tired because of your hearing difficulty?
never rarely sometimes often almost always

SSQ12 Instructions

The following questions inquire about aspects of your ability and experience hearing and listening in different situations.

For each question, put a mark, such as a cross (x), **anywhere** on the scale shown against each question that runs from 0 through to 10. Putting a mark at **10** means that you would be **perfectly** able to do or experience what is described in the question. Putting a mark at **0** means you would be quite **unable** to do or experience what is described.

As an example, question 1 asks about having a conversation with someone while the TV is on at the same time. If you are well able to do this then put a mark up toward the right-hand end of the scale. If you could follow about half the conversation in this situation put the mark around the mid-point, and so on.

We expect that all the questions are relevant to your everyday experience, but if a question describes a situation that does not apply to you, put a cross in the "not applicable" box. Please also write a note next to that question explaining why it does not apply in your case

[redacted]	**Today's date**	**Your age**

Please check one of these options:

- I have **no** hearing aid/s ☐
- I use **one** hearing aid (**left ear**) ☐
- I use **one** hearing aid (**right ear**) ☐
- I use **two** hearing aids (**both ears**) ☐

If you have been using hearing aid/s, for how long?

Left ear	***Right ear***
______ years	______ years
______ months	______ months
or _____ weeks	or _____ weeks

1. You are talking with one other person and there is a TV on in the same room. Without turning the TV down, can you follow what the person you're talking to says?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

2. You are listening to someone talking to you, while at the same time trying to follow the news on TV. Can you follow what both people are saying?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

3. You are in conversation with one person in a room where there are many other people talking. Can you follow what the person you are talking to is saying?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

4. You are in a group of about five people in a busy restaurant. You can see everyone else in the group. Can you follow the conversation?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

5. You are with a group and the conversation switches from one person to another. Can you easily follow the conversation without missing the start of what each new speaker is saying?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

6. You are outside. A dog barks loudly. Can you tell immediately where it is, without having to look?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

7. Can you tell how far away a bus or a truck is, from the sound?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

8. Can you tell from the sound whether a bus or truck is coming towards you or going away?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

9. When you hear more than one sound at a time, do you have the impression that it seems like a single jumbled sound?

Jumbled 0 1 2 3 4 5 6 7 8 9 10 *Not jumbled*

Not applicable ☐

10. When you listen to music, can you make out which instruments are playing?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

11. Do everyday sounds that you can hear easily seem clear to you (not blurred)?

Not at all 0 1 2 3 4 5 6 7 8 9 10 *Perfectly*

Not applicable ☐

12. Do you have to concentrate very much when listening to someone or something?

Concentrate hard 0 1 2 3 4 5 6 7 8 9 10 *No need to concentrate*

Not applicable ☐