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Outcome of Surgery on Neurocognitive Functioning in Patients with Otic Capsule Defects

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in Patients with Otic Capsule Defects

by

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Abstract

There are two forms of otic capsule defect: Perilymph Fistula (PLF), a tear that typically occurs in the round window; and Superior Semicircular Canal Dehiscence (SCD), a thinning or absence of bone between the otic capsule and the brain. Symptoms of either may comprise mild to severe disturbances in the vestibular and auditory systems. These may be accompanied by various cognitive inefficiencies. Neurotologists, Grimm, Hemenway, LeBray, and Black (1989) measured cognitive efficiency pre- surgery in 38 adults who had acquired PLF. Assessment revealed difficulty in: verbal and visual memory; attention/concentration; and mental flexibility. Despite their research, the reality of PLF remains controversial (Hornibrook, 2012; Hughes, Sismanis & House, 1990) as at present, there is no objective means of providing a firm diagnosis. In contrast, objective diagnostic tests can corroborate an SCD, yet no research has been conducted concerning cognitive functioning. This study mirrors Grimm et al.'s attempt to substantiate cognitive difficulties in patients with otic capsule defects. Participants were recruited through the Ear and Skull Base Center, at Legacy Research Institute, in Portland, Oregon. The sample consisted of eighteen participants, including five adolescents. The treatment plan

included these pre and post-surgical neuropsychological assessments: intelligence, attention/concentration, processing speed, working memory, and mental flexibility. Assessments were administered six to one week(s) prior to surgery; two to three months following surgery; and nine to twelve months later. Scores were analyzed using analysis of variance for repeated measures. Similar to the findings of Grimm et al, pretest scores suggested possible impairment in cognitive functioning. Overall post-operative results indicated significant improvement in both cognitive and emotional functioning for PLF patients. Cognitive and emotional gains showed large effect sizes for the PLF participants, but more modest gains for the SCD participants. Although otic capsule defects affect a small segment of the population, its continued examination may have broader applications. SCD patients have similar patterns of cognitive function, however they have earlier brain reorganization and less dramatic changes post-operatively. Conversely, as PLF typically develops later, results demonstrated dramatic post-operative changes. This information may be helpful in diagnosing, monitoring, and developing comprehensive rehabilitation plans.

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Chapter 1

Introduction

Gravity comprises a synergy of forces between any two objects in the universe. Without it, people and animals would not be attracted to the earth and we would, in all likelihood, float off into space. It is multidimensional, and on a universal scale, gravity holds the key to the formation of the tides; the orbits of planets; and genesis of galaxies and stars. When gravity is present without an opposing force, either net force or torque, to counteract its pull, it will collapse the stars in space and unbalance matter on earth. In humans, this circumstance is actualized as a vestibular disorder.

Carter and colleagues state that proprioception is, “according to some scientists, our sixth sense” (Carter, Aldridge, Page & Parker, 2009, p. 102). Balance consists of a “complex set of sensorimotor control systems that include vision, proprioception [touch], and the vestibular system [motion, equilibrium, spatial orientation]; integration of that sensory input; and motor output to the eye and body muscles” (Vestibular Disorders Association [VDA], 2015). Connected to the cochlea, and sharing endolymphatic fluid with it, are the three semi-circular canals of the inner ear; their work is to maintain equilibrium within our gravitational system. Without the complex system of proprioception and kinesthesia, e.g., the sensations of muscle activity, acceleration, and enervation, as well as the visual perception that controls our physical balance, gravity would be the prime force at work. Without these complex systems, the activities of a ballerina or gymnast, or even a simple task like walking, would be impossible. At best we might be characterized as clumsy, with an unsteady gait, crashing into walls, or falling over.

The vestibular apparatus is the organ that senses head position relative to gravity (Gray, 2015, p. 104). Balance is defined as a state in which two or more opposing forces or factors are of equal strength so that they effectively cancel each other out and stability is maintained. When we and the earth are attracted to each other, our neurobiology allows us to achieve balance, the ability to maintain our physical positions in space. According to Pirie, “all cellular developmental phenotypes are driven in some small part by gravity” (Christopher Pirie, personal communication, February 5, 2013). Balance and spatial equilibrium are driven by gravitational effects on the crystals or otoliths (Greek: *oto*, ear; *lithos*, a stone) inside the cells of the of the vestibular system within the inner ear. Otoliths are small particles composed of a combination of a gelatinous matrix and calcium carbonate that reside in the viscous fluid of the saccule and utricle, organs within the vestibular labyrinth.

> Displacements and linear accelerations of the head, such as those induced by tilting or translational movements are detected by [these] two otolith organs. Both . . . contain a sensory epithelium . . . which consists of hair cells and associated supporting cells. Overlying the hair cells and their hair bundles is a gelatinous layer, and above this is a fibrous structure, the otolithic membrane, in which are embedded crystals of calcium carbonate called otoconia” (Purves, D., Augustine, G. J., & Fitzpatrick D., 2001).

According to Gray (2015, Vestibular System section, para. 10.1), when the head moves, the inertia of these small particles causes them to stimulate the stereocilia, the uppermost part of the hair cell that senses mechanical movement. When the head changes position or begins a movement, the weight of the otolithic membrane bends the stereocilia, thus stimulating the hair cells. The roots of the hair cells are connected to bundles of afferent nerves that constitute the

Vestibulocochlear nerve. Electrical signals arrive at the vestibular nuclear complex in the brainstem, and are interpreted by the brain as motion. The stereocilia are stimulated in the same manner as mechanical movement during both linear acceleration and deceleration, as seen in Figure 1 below.

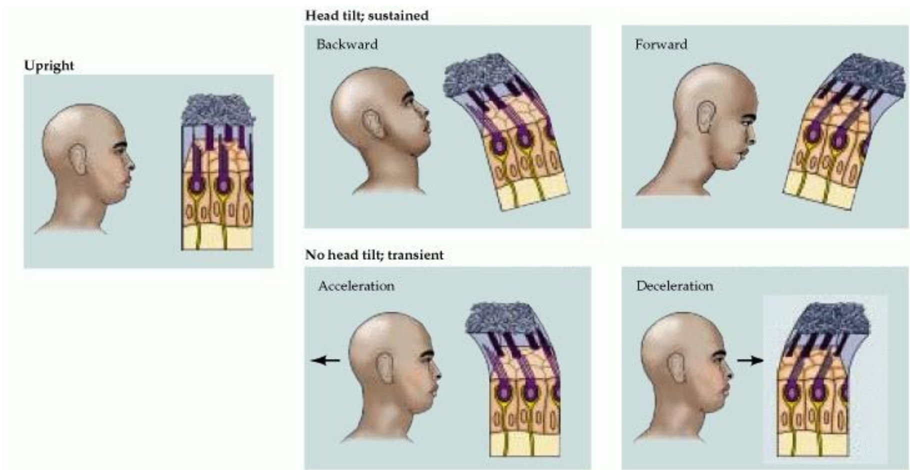

Figure 1. Stereocilia displacement resulting from mechanical and linear movement on the head (Wolfe, Kluender & Levi, 2015, retrieved from: Gravity Versus Linear Acceleration section, para. 12.1).

Comparison of input from the utricles and saccules from both ears with input from the eyes, allows the brain to discriminate the difference between a tilted head movement and movement of the entire body. By virtue of their positions, the utricle is sensitive to changes in horizontal movement, e.g., when driving a car. The saccule is sensitive to changes in vertical acceleration, e.g., when jumping, taking off and landing in an airplane, or traveling in an elevator. The pull of gravity repositions the hair cells to the side, causing distortion, which sends a message to the central nervous system that the brain is no longer level.

If the otoliths are somehow dislodged from their designated location, there is a tear in the lining of one of the semi-circular canals, or the temporal bone separating the semicircular canals from the base of the brain becomes thinned or disappears altogether, the vestibular system can become compromised.

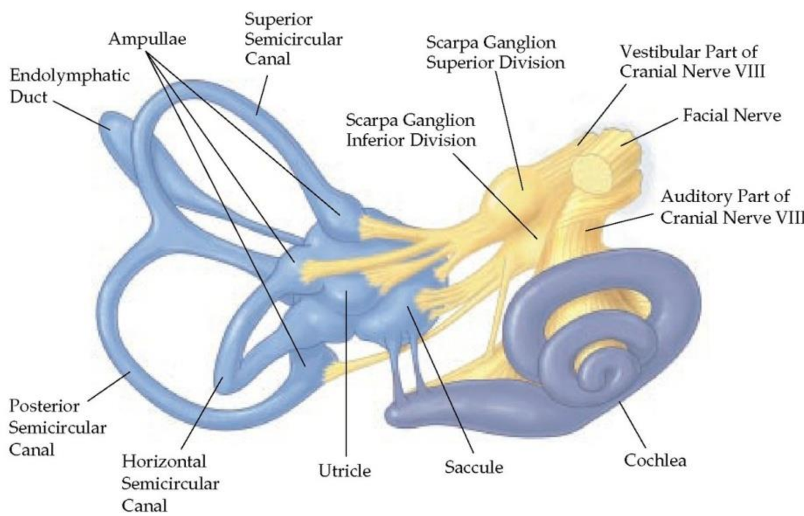

Figure 2. Soft tissue structures within the vestibular labyrinth (Prasad, 2015, retrieved from: Acoustic Neuroma section).

There is a term derived from Old English used to describe those with hearing loss or deafness. Interestingly, these words also allude to the vestibular symptoms observed in individuals who have otic capsule defects. Both words, *deaf* and *dumb*, in this phrase come from the same source: The common denominator ‘sensory or mental impairment’ goes back to the Indo- European base *dheubh*, which denoted ‘confusion, stupefaction, dizziness.’ It produced Greek *tuphlós* ‘blind’; English *dumb*; and a prehistoric Germanic adjective *daubaz* ‘dull, stupefied, slow.’ (Ayto, 2005).

Individuals who have otic capsule defects often present with *confusion*, *stupefaction*, and *dizziness*, as well as *deafness*. Two forms of otic capsule defects manifest similar vestibular disruption and symptomology: Perilymph Fistula (PLF) and Superior Semicircular Canal Dehiscence (SCD). The first of these disorders is caused by a tear in one of the semi-circular canals of the inner ear, causing leakage of endolymphatic fluid. In the second, symptoms are induced by a thinning, or in some cases, complete absence, of the bony cap between the superior semicircular canal and the dura that protects the temporal lobe. Diagnosis of SCD is obtained via computed tomography scan (CT) and vestibular evoked myogenic potentials. However, no conclusive objective measures exist to diagnose PLF. As such, its existence has been steeped in controversy for nearly 50 years. It is seemingly elusive. “The only way [a definitive] diagnosis can be confirmed is by performing a surgical procedure called tympanotomy, and directly viewing the area of the fistula. If a fluid leak is seen, a perilymph fistula is assumed to be present” (VDA, 2015, Diagnosis section, para. 1). Unlike SCD, many cases of Perilymph Fistula occur as a result of head injury. This factor increases the difficulty in obtaining an exact diagnosis of PLF as symptoms of both PLF and concussion often occur in a parallel and intersecting fashion. To perform due diligence, neurotologists (physicians who specialize in base skull neurology) rely on a combination of subjective and objective data: patients’ histories, audiometric, and vestibular testing.

Symptoms of balance disorders, while demonstrating individual differences, do share some common features, including, but not limited to, cognitive inefficiencies. When the superior, horizontal, or posterior semi-circular canal is torn or otherwise compromised, endolymphatic fluid leaks out and disrupts the precise interplay of mechanics and chemistry and the related

neurological functioning necessary for auditory and vestibular equilibrium. The symptoms of a perilymph fistula frequently observed are: Dizziness and/or vertigo; disequlibrium; nausea; aural fullness; tinnitus; fluctuating or static hearing loss; hyperacusis; and cognitive inefficiencies (P. Ashley Wackym, personal communication, October 15, 2015). Additionally, patients diagnosed with SCD, have reported feeling as if the aisles in the supermarket are closing in on them, and ossiculopsia -- the sensation of walking as if on a trampoline. They have also reported the ability to hear internal sounds of their bodies, e.g., eye movement autophony. In both disorders, symptoms may worsen with change in altitude, e.g., elevators, airplanes, driving over mountain passes; or with changes in air pressure cause by weather changes, scuba diving, childbirth, etc. Additional situations that exacerbate symptoms are visual patterns on walls or clothing, such as stripes, polka dots, checks; crowded places; driving in traffic; being in a location with multiple speakers; windshield wipers; escalators and stairs (Grimm, Hemenway, LeBray, & Black, 1989). An increase in exercise and activity may induce or worsen symptoms of dizziness. .

Other perceptual and cognitive difficulties may include atypical responses to: “patterns (stripes, dots, and checks); stairways; printed text; multiple voices… [difficulty with referential movement] of elevators; escalators; revolving doors; airport luggage carrels; moving water; heavy traffic; windshield wipers; and crowds” (Grimm et al, 1989, p. 16). Cognitive inefficiencies in Perilymph Fistula patients were demonstrated by Grimm et al, in their study, *Perilymph Fistula Syndrome Defined in Mild Head Trauma*, in which “curious aberrations crop up in short-term memory, concentration, and reading . . . as a result, workers lose efficiency, make mistakes, and exhaust themselves trying to keep pace” (Grimm et al., 1989). Grimm et al.’s is the only known study about Perilymph Fistula in which cognitive assessment was conducted

before surgical intervention. A review of the literature revealed no known research concerning cognitive functioning in those who have SCD.

Though a low incidence disorder, like many chronic illnesses, otic capsule defect is costly. The Centers for Disease Control and Prevention estimate that 75% of all healthcare and healthcare related costs are due to chronic diseases (Centers for Disease Control [CDC], 2009). An estimated 5.3 million Americans live with traumatic brain injury-related disabilities, and

> children aged 0 to 4 years, older adolescents aged 15 to 19 years, and adults aged 65 years and older are most likely to sustain a TBI. Falls are the most common cause of traumatic brain injury at 40.5%; and in those 65 years old and older, this number doubles to 81%. Adjusted for inflation, the direct medical costs for fall injuries are $34 billion annually (CDC, 2016, p. 1).

There are costs to the insurance industry as patients seek specialist after specialist, undergo tests, procedures, surgery, vestibular and/or cognitive rehabilitation, and not infrequently engage in psychotherapy. Marriages in which a spouse has a chronic medical condition(s) and/or disability(ies), when compared to marriages in which neither spouse is affected by a chronic condition, demonstrated an increased rate of divorce of between 1.4 – 1.9 % (Cohen, 2013, para. 3).

When children are involved, regardless of disability status of the parent(s), once a marriage is ended, the financial capital of the custodial parent is negatively affected, in turn negatively affecting the child’s social capital, resulting in less financial, academic and emotional stability overall for the child (McLanahan & Sandefur, 1997). Also, children raised in families having less social capital and economic power due to parents with chronic medical conditions “displayed more

internalizing problems than the comparison [normative] group and scored higher on frequency of household chores, caregiving responsibilities, activity restrictions, isolation, daily hassles and stress" (Sieh, Visser-Meily, & Meijer, 2013, Differential Outcomes in Behavioral, Psychosocial, and Academic Domains section). Rutter and Quinton (1984) found "The children of psychiatric patients had an increased rate of persistent emotional/behavioral disturbance, which tended to involve disorders of conduct" (Abstract section, para. 1).

There are economic consequences of otic capsule dehiscence as a result of lost productivity (Davis, Collins, Doty, Ho, & Holmgren, 2005) which can be seen in the demographics of the patients at the Ear and Skull Base Center: 83.33 % of the patients have had to stop working due to the severity of their symptoms. Six of these participants became financially dependent on their partners/spouses, a stressor in addition to the stress of illness; the rest of the participants obtained alternative financial assistance, e.g., unemployment benefits or Social Security Disability Insurance.

Anecdotal narratives as told by patients experiencing symptoms of otic capsule defects/in our clinic, commonly illustrated cognitive inefficiencies. However, interpretations tended toward the psychopathological rather than toward issues of memory, learning, concentration, processing speed, executive functioning and intellectual abilities that Grimm, et al. emphasized. Patients reported being told things such as: "[it's] all in your head," or something to that effect, by family members, friends, primary care physicians, neurologists, psychiatrists and psychologists. "Based on our clinic records, several patients had seen an average of 11 specialists before finding a specialist familiar with this diagnosis" (P. A. Wackym, personal communication, October 15, 2012). According to clinic records, others previously had been given a diagnosis under the

Diagnostic and Statistical Manual of Mental Disorders (*DSM-IV;* American Psychiatric Association, 1994) rubrics such as Conversion disorder, Borderline personality disorder, Bipolar disorder, Panic disorder, Obsessive-compulsive disorder, or Histrionic personality disorder. Grimm et al. (1989) included the MMPI in their research assessment battery and reported significant effect sizes for these psychiatric domains: Hypochondriasis (1), Depression (2), Hysteria (3), Psychopathic Deviate (4), Paranoia (6), Psychasthenia (7), and Schizophrenia (8) (MMPI scales 1 2, 3, 4, 6, 7, 8 respectively).

The original research study on PLF, conducted by Grimm et al (1989), found evidence that following surgery for PLF, patients demonstrated significant gains in memory and learning; attention and concentration; and mental flexibility. The professional literature shows there is a difference of opinion among neurotologists in America as to whether the constellation of symptoms that point to a diagnosis of PLF are truly symptoms of a surgically correctable condition, or due to psychological distress (Black & Peszenker, 1992; Cole, 1995; Fitzgerald, 1993; Friedland & Wackym, 1999; Hornibrook, 2012; Ikezono, Shindo, & Sekiguchi, 2011; Maitland, 2001; Shea, 1992). To date, there are no known data assessing the effect of SCD on cognitive efficiency.

There is a two-fold objective in demonstrating the cognitive change in patients with otic capsule defects: (a) To corroborate findings to Grimm, et al., and to demonstrate that cognitive inefficiency can provide an additional diagnostic tool for PLF; and (b) to provide support, through the same battery of tests used to assess cognitive functioning with PLF patients, for the hypothesis that SCD has a negative effect on cognition similar to that of PLF. This study attempted to mirror, as closely as possible the methodology of Grimm et al., to assess whether

Grimm et al.’s findings can be replicated. No other methodological approaches were considered as the parameters of the study were intentionally limited to this objective by the Director of Research. The research question is whether we can replicate Grimm et al.’s finding of higher cognitive functioning following PLF surgery. Also, using the same methodology, a second objective of this study is to determine whether similar cognitive effects occur in those patients with SCD.

Chapter 2

Methods

Participants

Participants comprised 18 adult and 5 adolescent patients of the Ear and Skull Base Center, ranging in age from 13-62 years, who have been diagnosed and have made the decision to have surgery to repair Perilymph Fistula (PLF) or Superior Semicircular Canal Dehiscence (SCD). Thirteen patients came to the clinic for surgical repair of PLF, seven for SCD, and three for both PLF and SCD. Of the adult patients, 3 were male, and 15 were female. The adolescent group was nearly evenly split with 2 male and 3 female patients. Most of the participants declared themselves as European American; one adult was African American; and one of the adolescent patients was Asian American. Patients of this clinic were aware the clinic has an additional role as a research facility, and research participation was voluntary. The clinic does not accept Medicare, Medicaid or uninsured patients; therefore, the socio-economic floor of the participants began at middle class.

Most of the adult participants hold an AA degree or above, and had they not been disabled and thus receiving government financial assistance, likely would have continued employment in salaried positions. Three of the adolescent participants were able to continue to attend school with varying academic success. One had to limit her attendance to one class period per day and received private, in-home tutoring for her other subjects; another’s symptoms were severe enough to preclude even in-home tutoring or home schooling. Of the adults, 12 participants were married, while 7 were unmarried and not in a committed relationship. None of the adolescent participants were married, and all lived at home in two-parent households. The majority of the participants

were from the Portland metropolitan or outlying areas. Several were from out-of-town, e.g., Walla Walla, WA; Seattle, WA; Spokane, WA; Phoenix, AZ; and Kansas City, MO.

Comparison of this sample patient population with that of Grimm, et al. reveal disparate ratios of gender; regrettably, ethnic, racial, SES and education attainment information was not provided in Grimm's study. Tables 1 and 2 below summarize demographic information from the two studies:

Table 1

Demographics of Sample Population

	Population	Mean Age	SD	Male	Female
Adults	18	47.06	8.28	4	14
Adolescents	5	15.20	1.64	2	3

Table 2

Demographics of Grimm, et al. (1989)

Population	Mean Age	SD	Male	Female
38	35.3	10.8	17	21

There does appear to be an average difference of 12 years between the two cohorts (not including the adolescent population of the current study), with the current sample population at the higher end of the age continuum. Also, gender is more evenly split in Grimm et al.'s study than in the current one. Although demographic information provided by Grimm et al. was nominal,

information about study participants' overall intellectual abilities was presented, affording an imagined floor of potential educational and professional attainment. Grimm et al.'s patients demonstrated an average FSIQ of 91.54 (average range) from the WAIS R (an earlier version of both the WAIS III and WAIS IV). The two main indices, Verbal IQ and Perceptual IQ, had average scores of 91.87 and 94.29, respectively; both scores lie within the average range of intellectual abilities (Grimm et al., 1989).

Instruments

An exact replication of Grimm et al. (1989) proved to be impractical as several of the published assessment instruments have since undergone revisions intended to reflect relevance in a changing cultural context. The most recent editions of these assessments were used as part of the pre- and post-surgical assessment batteries. Also, due to the restrictions imposed by participants' varying otic capsule symptoms, prolonged sessions of testing proved impractical. For that reason, either a shorter version of an assessment was utilized, or it was replaced altogether by a comparable measure that correlated highly with the original. Additionally, a Likert scale was developed to capture the subjects' individual, subjective experiences of otic capsule dehiscence.

The participants underwent an initial pre-surgery assessment battery consisting of the following:

1. Beck's Depression Inventory, 2nd Ed.
2. Either the Wechsler Adult Intelligence Scale, 4th Ed., Verbal Comprehension Index, Perceptual Reasoning Index, and Processing Speed Index, or the Wide Range Intelligence Test

3. Wide Range Assessment of Memory and Learning, 2nd Ed.

4. Delis-Kaplan Executive Function System, Trail Making Test Conditions 4 and 5

5. PLF/SCD Symptoms Rating Sheet (see Appendix A)

6. Videos of patients' qualitative comments collected before and after otic capsule surgery (see Appendix A)

All but the PLF/SCD Symptoms Rating Sheet are published measures. The PLF/SCD Symptom Ratings Sheet is used as a screening instrument at the Ear and Skull Base Center. Dr. Wackym also obtains videotapes of all of his surgical patients both pre and post-operatively. The only assessment substitution that was not directly comparable is the Beck Depression Inventory-II, used in place of the Minnesota Multiphasic Personality Inventory (MMPI) and the Symptom Checklist 90-Revised (SCL-R), again due to time and symptom constraints. Other tests in the Grimm study test battery were the Wechsler Adult Intelligence Scale-Revised (WAIS-R); Wechsler Memory Scale (WMS); Rey Auditory Verbal Learning Test (RVLT), a test analogous to the Verbal Learning subtest of the WRAML-2 (described further on in the text); and the Trail Making Tests A and B (comparable to the D-KEFS Trail Making Test Conditions 4 and 5). Descriptions of the published assessments used in this study are as follows:

Beck Depression Inventory II (BDI-2; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). The BDI-2 is a self-report measure used to measure the *severity* of depression and is not a diagnostic tool (Beck, 1972). It is designed for individuals 13 years of age or older, and consists of items covering emotional, physical, and cognitive symptoms related to depression. It contains 21 questions; each answer is scored on a scale value of 0 to 3. Higher total scores indicate more severe depressive symptoms. The standardized cutoffs are: 0–13: minimal depression; 14–19:

mild depression; 20–28: moderate depression; 29–63: severe depression. The BDI- 2 demonstrated a reliability coefficient alpha of .92 for the outpatient population (*n* = 500) discussed in the technical manual. A one week test-retest correlation of .93 (significant at $p < .001$) resulted from a study of 26 outpatients who had been referred for depression and took the BDI-2 at their first and second sessions of counseling. The first-session mean BDI-II total score of 20.27 (*SD* = 10.46) and the second-session mean BDI-II total score of 19.42 (*SD* = 10.38) were comparable [paired r (25) = 1.08, not significant] (Beck et al., 1961).

Additional analysis revealed,

> Retest reliability (Pearson's r) showed relative stability through re-application of the BDI-II, with good to excellent coefficients (range, 0.73 to 0.96), with a mean re-application interval of two weeks (range: 1 week to 6 months) for the majority of studies (82%). (Wang & Gorenstein, 2013)

These results point toward internal test stability, i.e., week-to-week fluctuations in mood are not likely to adversely influence the overall affective state captured by test items (Beck, Steer, & Brown, 1996). This stability is referred to as internal validity, the degree to which a test measures a construct it was designed to measure.

Wechsler Adult Intelligence Scale IV (WAIS IV; Coalson & Raiford, 2008). The WAIS IV is a comprehensive intellectual abilities assessment for individuals ranging in age from 16 – 90.11 years. Composite scores obtained from a full battery represent intellectual functioning in four cognitive domains: Verbal Comprehension Index (VCI); Perceptual Reasoning Index (PRI); Working Memory Index (WMI); and Processing Speed Index (PSI). For the purposes of this study,

the select indices of Verbal Comprehension; Perceptual Reasoning, and Processing Speed were used. The internal consistency data ranged as follows in Table 3 (Coalson & Raiford, 2008):

Table 3

Select Indices of Coalson & Raiford's WAIS-IV

SUBTEST	Reliability	Standard Error of Measurement
VCI	.96-.98	2.85
PRI	.92-.96	3.48
PSI	.87-.92	4.78

Correlations of these domains with comparable domains of the WRIT are discussed in the next section. Validity data of the WAIS IV Processing Speed Index (normative sample; *n* = 71) with the Delis-Kaplan Executive Function Systems, Condition 4 completion time (Number-Letter Switching) is .72, with total errors regardless of type, .47 (Coalson & Raiford, 2008).

Wide Range Intelligence Test (WRIT; Glutting, Adams & Sheslow, 2000). The WRIT is a brief intellectual ability measure, consisting of four subtests, divided into two domains: Verbal Intelligence and Perceptual Intelligence. The subtests Verbal Analogies and Vocabulary comprise the Verbal Index, while Matrices and Diamonds comprise the Perceptual Index. Data obtained from the WRIT Technical Manual showed the test-retest reliability data for adults, age 19 to 85 years (*n* = 32), the mean time interval between each test was 30.5 days, for each of the subtests, to be as follows (Glutting, Adams & Sheslow, 2000):

Table 4

WRIT Subtests Data

Subtest	Stability	Standard Error of Measurement
Vocabulary	.93 (85)	5.5
Verbal Analogies	1.00 (.90)	8.4
Matrices	.91 (.82)	5.9
Diamonds	.72 (.67)	6.2

The reliability coefficients for item separation or how accurately the items measure various elements across scores and across time, for all four subtests ranged from .72-1.00 (corrected).

The data for test-retest stability of the WRIT is important to this study as participants took it at least three times, pre-surgery and twice post-surgery. Most of the participants, with the exception of three adults and one of the adolescents, participated in a third administration at six to twelve months post-surgery. Average score gains from the first testing to the second, obtained from normative data participants are as follows in Table 5.

There are two aspects to the validity of the WRIT, internal and external. For the purposes of this study, external validity will be the focus. Table 6 shows the correlations between the WAIS III and the WRIT for FSIQ, Verbal IQ and Perceptual IQ (Glutting, Adams, & Sheslow, 2000).

Table 5

Score Gains for WRIT IQ Scales and Subtests for Test-Retest Participants (n = 32)

First Testing	FSIQ	Vocabulary	Verbal Analogies	Matrices	Diamonds
Mean	102.5	105.9	101.6	98.5	101.6
SD	18.3	14.9	17.6	17.3	17.6
Second Testing					
Mean	107.4	105.9	101.6	98.5	101.6
SD	16.5	15.7	16.4	16.7	16.2
Average Gain	4.9	1.3	6.0	4.5	3.5

Table 6

Correlations between the WAIS III and the WRIT

INDEX	Validity
FSIQ	.91
VERBAL IQ	.90
PERCEPTUAL IQ	.85

These data show that the WRIT provides a good approximation of WAIS III scores. In the present study the WRIT was used for participants whose symptoms precluded use of the WAIS IV, a longer assessment measure.

Wide Range Assessment of Memory and Learning, Second Edition (WRAML-2; (Sheslow & Adams, 2001). The WRAML-2 was designed “to provide a psychometrically sound measure of important Core memory components” (Sheslow & Adams, 2003). There are six core subtests comprising the WRAML-2, with nine optional subtests available for participants aged 18-89. The core subtests measure the Verbal, Perceptual and Attention/Concentration Indices, while two optional subtests encompass the Working Memory Index. Additional optional subtests measure verbal and visual memory delay recall and verbal and visual memory recognition. Internal reliability is the consistency of scores across items. The internal consistency reliability figures for the core indices, as well as an overall memory index, for those aged 18-89.11 (*n* = 640) of the WRAML-2 are as follows in Table 7.

Table 7

Internal Consistency and Reliability for the WRAML-2

INDEX	Reliability
Verbal Memory	.91-.94
Perceptual Memory	.84-.93
Attention/Concentration	.83-.91
General Memory	.93-.95

As working memory is a significant component of cognitive functioning in patients who have PLF, the reliability figures were obtained and are .76-.88 for those aged 18-.89.11 years. The internal validity of this test refers to the degree to which the WRAML-2 measures the construct of

memory. For the purposes of this study, the item content and subtest intercorrelations will be addressed. The range of subtest item separation is reported to be between .98 and 1.00 , while subtest inter-correlations for those aged nine years or more (n=880) demonstrate a “low to moderate” correlation with the other subtests, and are significant at .01 (Sheslow & Adams, 2001).

Delis Kaplan Executive Functions System Trail Making Tests Conditions 4 and 5 (D-KEFS; Delis, Kramer & Kaplan, 2001). The Trail Making Tests were designed as a measure of executive functioning, specifically in relation to higher level skills such as “multitasking, simultaneous processing and divided attention” (Delis, Kramer, Kaplan, & Holdnack, 2004). There are five trails in all. However, for the purposes of this study, patients were only assessed with two, Number-Letter Switching (Condition 4) and Motor Speed (Condition 5). Number-Letter Switching requires the examinee to mentally shift from one task to another, specifically shifting back and forth connecting dots from numerical to alphabetical order. Motor Speed measures how quickly the examinee can connect a series of dots, providing a baseline level of motor functioning. The contrast between these two conditions “provide normative data regarding the extent to which difficulty on the switching condition may be related to a motor deficit” (Delis et al., 2001).

The D-KEFS was standardized on a nationally representative, stratified sample of 1,750 non-clinical children, adolescents, and adults, ages 8–89 years old. Test-Retest reliability studies were based on 101 participants across all age ranges, with time between administrations “25 ± 12.8 days” (Delis et al., 2001). Internal consistency is based on a composite score of Number Sequencing and Letter Sequencing conditions. The internal consistency of this composite score is analyzed by utilizing performance on each condition as an equivalent half test. The Spearman-Brown formula was used to correct correlation, deriving reliability coefficient of .66 for Combined

Number Sequencing and Letter Sequencing for all ages. Specific measures to this study, Motor Speed and Number/Letter Switching, demonstrated reliability of .77 and .38 respectively. Correlations for the ages represented in this study range from .68 (12 years of age) to .80 (60-69 years of age).

PLF/SCD Symptoms Rating Sheet. Similar to the 0-10 point Likert pain scale used in hospitals, the Symptoms Rating Sheet developed by the Ear and Skull Base Center is a self-report measure of symptom severity. The scale ranges from *Normal* (0) to *Disabling* (10) and patients are asked to rate their symptoms at three discrete points: *Now*, *Best*, and *Worst*. For symptoms directly related to the mechanical, cochlear, and retrocochlear functioning of the ear, patients specify which ear: *Left*, *Right*, or *Bilateral*. This is an *in-house* self-report measure designed for medical appointments for which there is no reliability, validity or test-retest data available.

Procedure

The principal investigator had personal contact with each participant due to the nature of the medical procedure and data collection. Each participant signed an Informed Consent for Psychological Testing, and completed a brief clinical interview. Data were gathered continuously over a period of two years. Participants were evaluated as they were referred to the clinic and accepted for surgery, with a 59.52% rate of involvement, and of those, 68% completed the pre-surgical and both post-surgical assessment batteries. They were given a cognitive assessment battery between six to one week(s) prior to their surgery. Patients were then re-evaluated two to three months following surgery and again 9 to 12 months following surgery. This study employed a one-group pre-test, post-test design, Campbell & Stanley's (1961) Design 2.

Participants were each assigned an identification number to protect their privacy. Data were kept on site in files separate from medical charts, in a locked cabinet at the Ear and Skull Base Center. Once all of the data were collected and entered into a sanitized spreadsheet, names were deleted from the data file.

Institutional Review Board approval was obtained from Christopher Koch, PhD, Director of Human Research at George Fox University. Each participant, or participant's parent or legal guardian, signed an Informed Consent Agreement prior to each testing session. Additional IRB approval was not required by the Ear and Skull Base Center.

Chapter 3

Data Results

Data were analyzed using repeated measures analyses of variance for each of the dependent measures. The repeated measures ANOVA is used to test the effects of a continuous dependent variable measured several times. The participants' results were then analyzed based on type of otic capsule defect: Perilymph Fistula, Semicircular Canal Dehiscence or both. Also, a between-subjects analysis of effects was completed. There were no significant effects due to type of otic defect at the p <. 05 level for the three conditions at Time One in any assessment domain: BDI-2 [$F(1, 15) = .023$, $p > .881$]; WRIT [F(1, 15 = .720, $p > .414$]; .Verbal Memory [$F(1,15) = 2.569$, $p > .135$]; Visual Memory [$F(1,15) = 4.510$, $p > .055$]; Attention/Concentration [$F(1,15) = .726$, $p > .411$]; Working Memory [$F(1,15) = .020$, $p > .891$]; Motor Speed [$F(1, 15) = .903$, $p > .361$]; and Number/Letter Switching [F(1,15 = .495, $p > .495$].

Moreover, data was analyzed for discrete aspects of possible effects of otic capsule defect. For instance, data was correlated for age; significance ($p < .05$) was found on the D-KEFS Number/Letter subtest only ($p < -.535$); no significant results related to age were obtained for the other subtests. Additionally, correlation of initial symptoms of depression with cognitive functioning denoted a non-significant negative correlation, suggesting that in this sample population, depression is unrelated to cognitive functioning before surgery. Results presented in Table 8 below.

Table 8

Pearson Product-Moment Correlation Coefficient of Depression with Pre-Operative Cognitive Functioning for Entire Sample

	WRIT FSIQ	WRAML2 Verbal	WRAML2 Perceptual	WRAML2 A/C	WRAML2 WM	DKEFS MS	DKEFS #/L
BDI-2	-.078	-.146	-.270	-.118	-.101	-.132	-.035

Subsequently, symptoms of depression were measured in correlation to post-operative improvements in cognitive functioning. As seen in Tables 9 and 10, there were no significant results obtained in this comparison, nor was there significance noted in analysis of depression change scores:

Table 9

Pearson-Product Moment Correlation Coefficient of Depressive Symptoms with Follow-up Cognitive Improvement for Entire Sample

	WRIT	WRAML2 Verbal	WRAML2 Perceptual	WRAML2 A/C	WRAML2 WM	DKEFS MS	DKEFS #/L
BDI-2	-.031	.235	.380	.000	-.095	-.047	-.213

Table 10

Pearson-Product Moment Correlation Coefficient of Changes in Depressive Symptoms with Post-Operative Cognitive Improvement for Entire Sample

	WRIT	WRAML2 Verbal	WRAML2 Perceptual	WRAML2 A/C	WRAML2 WM	DKEFS MS	DKEFS #/L
BDI-2 Change Scores	.039	.111	-.004	-.158	-.188	.180	-.045

Overall analysis of the effects of otic capsule surgery on cognitive performance were measured within these cognitive and affective domains: (a) affective symptoms of depression (BDI-2); (b) Full Scale Intelligence Quotient (FSIQ obtained with the WRIT); (c) Attention and Concentration (WRAML-2); (d) Verbal, Perceptual and Working Memory (WRAML-2); (e) Executive Function (D-KEFS), specifically cognitive flexibility, e.g., set shifting. Subjective responses on the PLF/SCD Symptoms Rating Sheet and video performances were also gathered but are not reported here.

Summary measures of central tendency of the sample population revealed patterns of cognitive and emotional improvement across testing occasions, from pre-surgical to post-surgical, even when results obtained are not statistically significant. Overall, FSIQ (WRIT) appeared to remain stable from pre-op through post-op and beyond [F (1, 15) = 2.12, $p < .14$]. Also, for this group, scores for the WRAML-2 Working Memory Index remained stable throughout all testing occasions [F (1, 15) = 1.60, $p < .22$]. Scores reported for depression (BDI-2) demonstrated significant improvement (F (1,15) = 10.24, $p < .001$); as did results for Verbal Memory (F (1,15) = 19.58, $p < .001$); Perceptual Memory (F (1,15) = 5.15, $p < .012$); Attention/Concentration (F(1,15) = 6.71, $p < .004$); Motor Speed (F (1,15) = 15.42, $p < .001$); and Number/Letter Switching (F

(1,15) = 5.10, $p < .013$). These are the same domains that were the most difficult for Grimm et al.'s study participants prior to surgery (Grimm, 1989). Regrettably, Grimm's study limited neuropsychological testing to pre-operative assessment only, consequently leaving no possibility for post-operative comparison. Table 11 below illustrates these reported outcomes for the sample population:

Table 11

Means, Standard Deviations, and Cohen's d Effect Sizes on Dependent Measures by Occasion for All Participants

Occasions	**1**		**2**		**3**							
Measures	*M* (*n*=18)	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p* *a* =.05	ES 1-2	ES 1-3	ES 2-3
BDI-2	19.59	11.95	9.19	10.12	8.53	10.57	1,15	10.24	<.001	.1.20	1.25	.08
WRIT	105.14	10.97	109.38	14.15	110.88	13.85	1,15	2.12	<.140	.35	.48	.13
WRAML-V	99.30	15.30	114.41	14.55	124.67	13.89	1,15	19.58	<.001	1.00	1.43	.59
WRAML-P	108.74	19.84	117.86	16.02	125.0	15.09	1,15	5.15	<.012	.57	.85	.39
WRAML-AC	87.71	21.59	98.34	12.27	106.22	14.93	1,15	6.71	<.004	.50	.98	.67
WRAML-WM	104.33	18.23	110.05	12.25	113.28	8.59	1,15	1.60	<.22	.56	.67	.32
DKEFS-MS	9.0	2.85	11.0	1.69	12.28	1.45	1,15	15.42	<.001	.77	1.22	.85
DKEFS-NL	7.86	4.20	11.18	1.79	11.22	1.83	1,15	5.10	<.013	.85	1.24	.02

Note: BDI-2 = Beck Depression Inventory, 2nd edition, WRIT = Wide-Range Intelligence Test, WRAML-V = Verbal Memory, WRAML- P=Perceptual/Visual Memory; WRAML A/C = Attention/Concentration; MS = Motor Speed; NL = Number/Letter Switching

Furthermore, the following Figures 3, 4, and 5 illustrate the changes in means over time for the sample population:

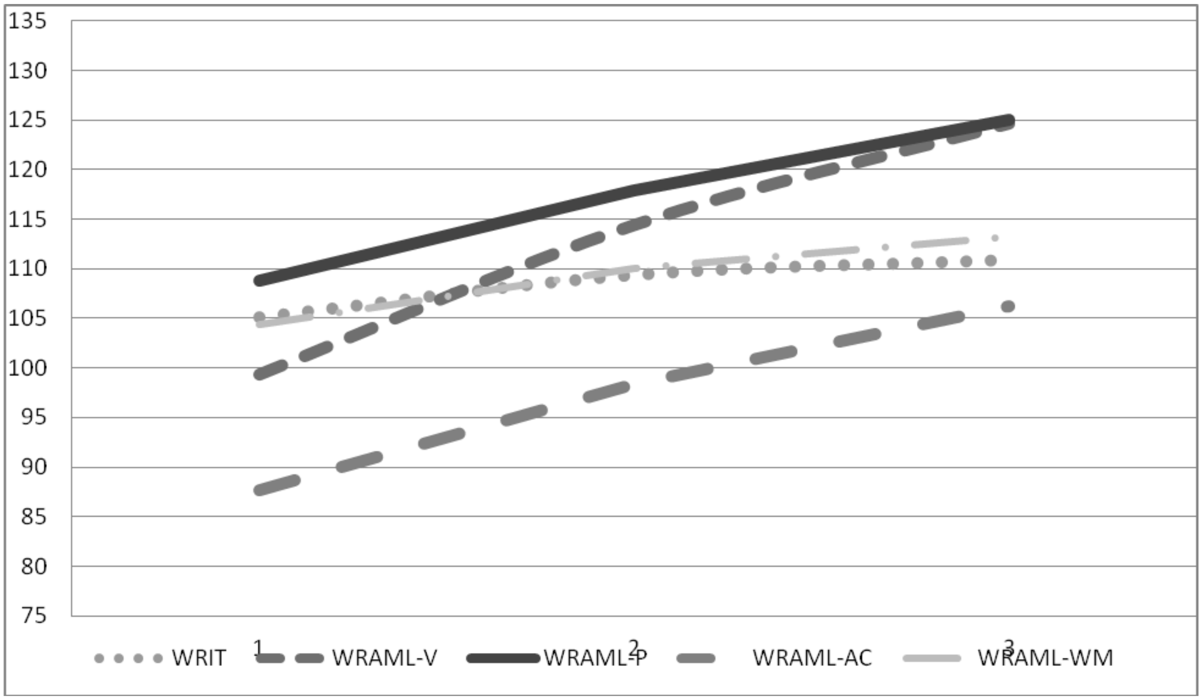

Figure 3. Changes in means from testing occasion one to occasion three for the WRIT and WRAML-2.

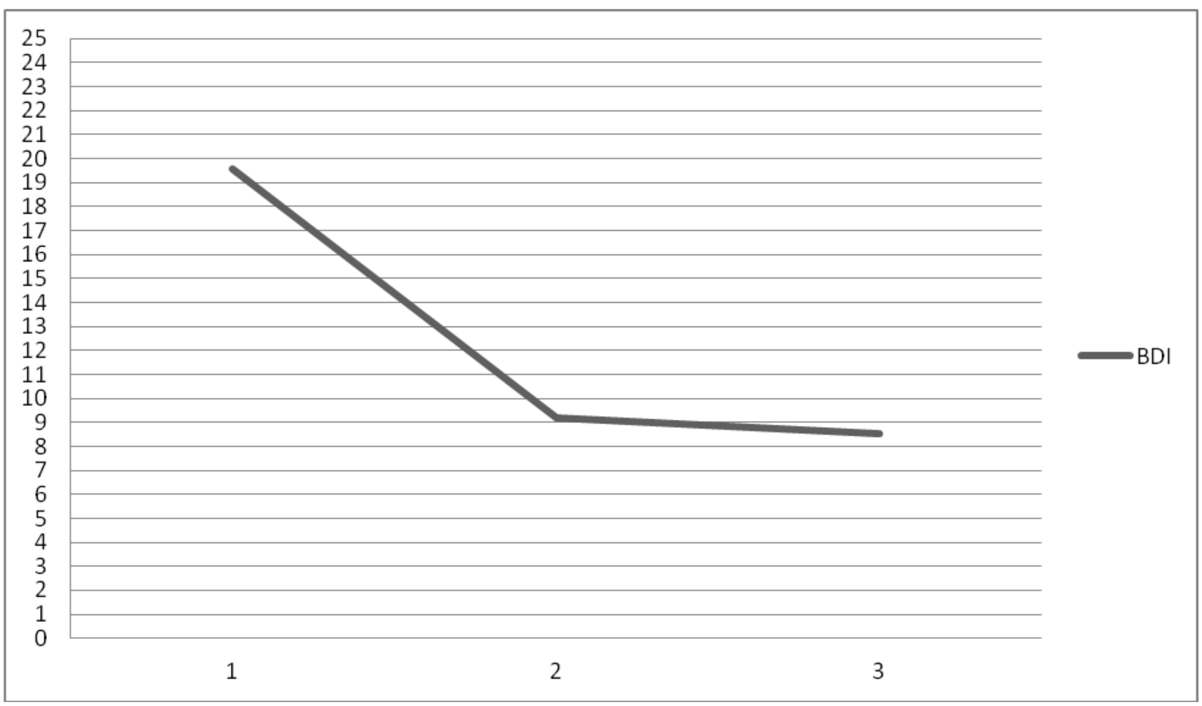

Figure 4. Changes in the means of sample population from testing occasion one to occasion three for the BDI-2.

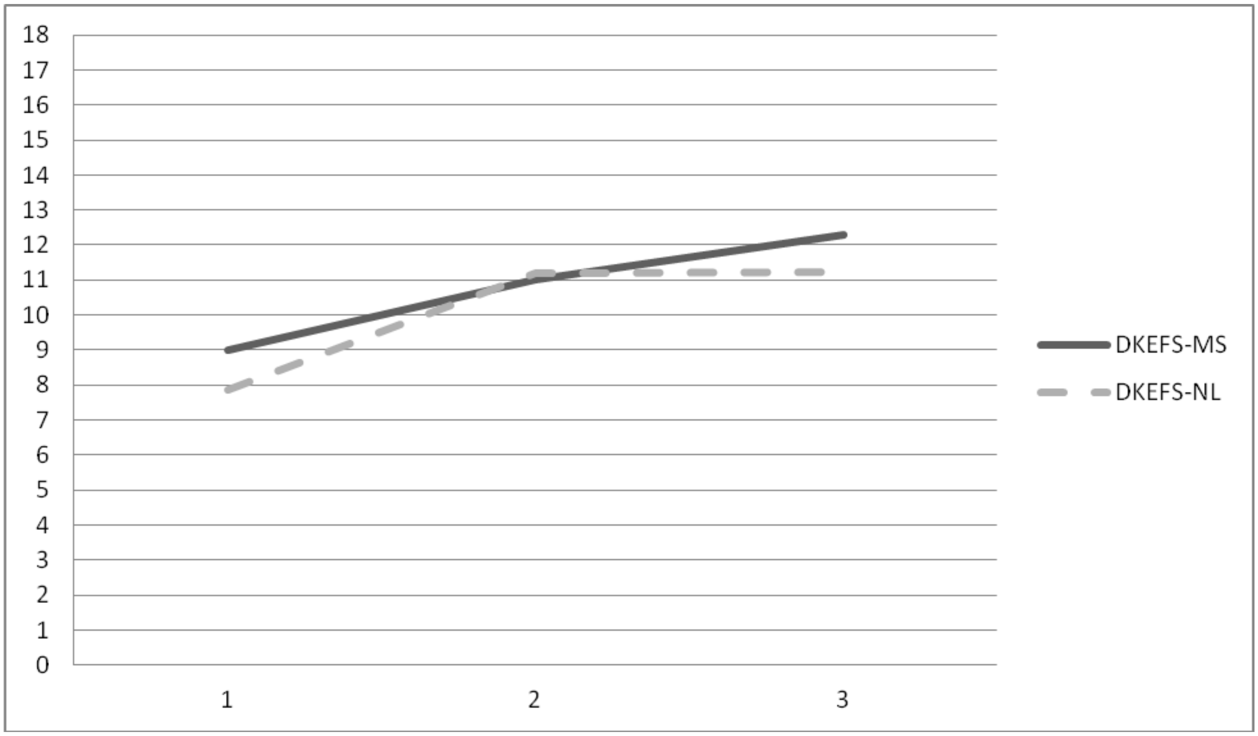

Figure 5. Changes in Means of sample population from testing occasion one to occasion three for DKEFS.

Similar trends were noted in the two population sub-groups, but results were more robust in the Perilymph Fistula group. The outcomes for the Semicircular Canal Dehiscence group did not demonstrate the same sort of consistent improvement across testing occasions as did the sample as a whole and the PLF group. The patients with Perilymph Fistula noted significant improvement in their depressive symptoms (F (1,8) = 16.38, p < .001); as well as in all cognitive areas assessed: FSIQ (F (1,8) = 6.2, p < .012); Verbal Memory (F (1,8) = 17.15, p < .001); Attention/ Concentration (F (1,8) = 10.32, p < .001); Working Memory (F (1,8) = 5.73, p < .013); Motor Speed (F (1,8) = 6.79, p < .007); and Number/Letter Switching (F (1,8) = 6.19, p < .011). Results for Perceptual Memory demonstrated more modest but significant results (F (1, 8) = 3.88, p <

.042), calling attention to consistent performance across all testing occasions for this group (see Table 12).

Table 12

Means, Standard Deviations and Cohen's d Effect Sizes on Dependent Measures by Occasion for Participants with Perilymph Fistula

Occasions	1		2		3							
	M (n=9)	SD	M	SD	M	SD	Df	F	*p* *a = .05*	ES1-2	ES 1-3	ES 2-3
BDI-2	21.833	14.64	11.08	12.41	7.44	11.01	1,8	16.38	<.001	.99	.95	.03
WRIT	102.73	11.07	108.64	15.34	111.25	8.28	1,8	6.2	<.012	.91	.92	.17
WRAML-V	96.00	17.75	114.83	15.05	127.56	13.59	1,8	17.25	<.001	1.42	1.68	.51
WRAML-P	106.15	22.92	121.00	18.09	128.11	11.33	1,8	3.88	<.042	.77	.91	.09
WRAML-AC	76.12	18.74	98.00	14.25	105.11	12.97	1,8	10.32	<.001	1.35	1.80	.48
WRAML-WM	97.55	17.39	109.36	12.44	116.78	9.83	1,8	5.73	<.013	.61	1.16	.56
DKEFS-MS	8.91	3.48	11.75	1.42	12.56	1.59	1,8	6.79	<.007	1.04	1.25	.47
DKEFS-NL	6.75	4.54	11.25	1.71	11.22	1.99	1,8	6.19	<.011	1.01	1.02	.06

Note: BDI-2 = Beck Depression Inventory, 2nd edition, WRIT = Wide-Range Intelligence Test, WRAML-V = Verbal Memory, WRAML- P=Perceptual/Visual Memory; WRAML A/C = Attention/Concentration; MS = Motor Speed; NL = Number/Letter Switching

The following Figures 6, 7 and 8, illustrate changes in means for all three occasions for the group of participants with Perilymph Fistula.

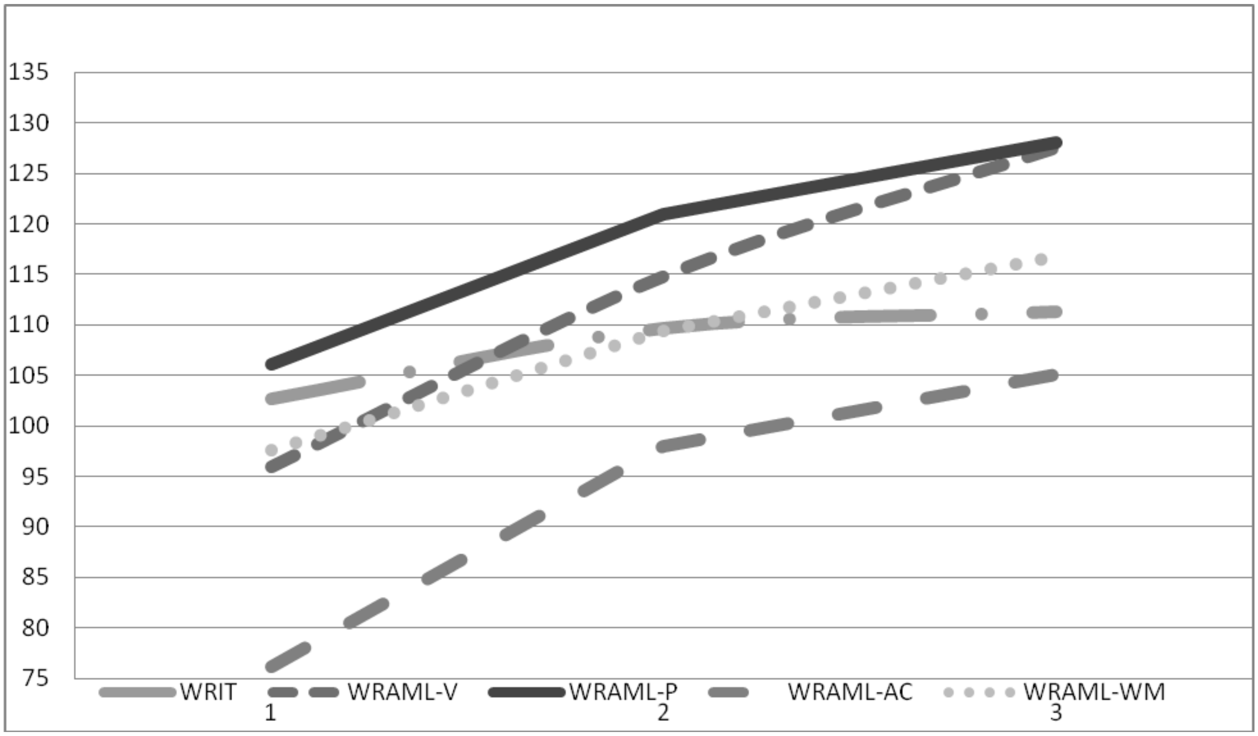

Figure 6. Changes in means of PLF Group from testing occasion one to occasion three for the WRIT and WRAML-2.

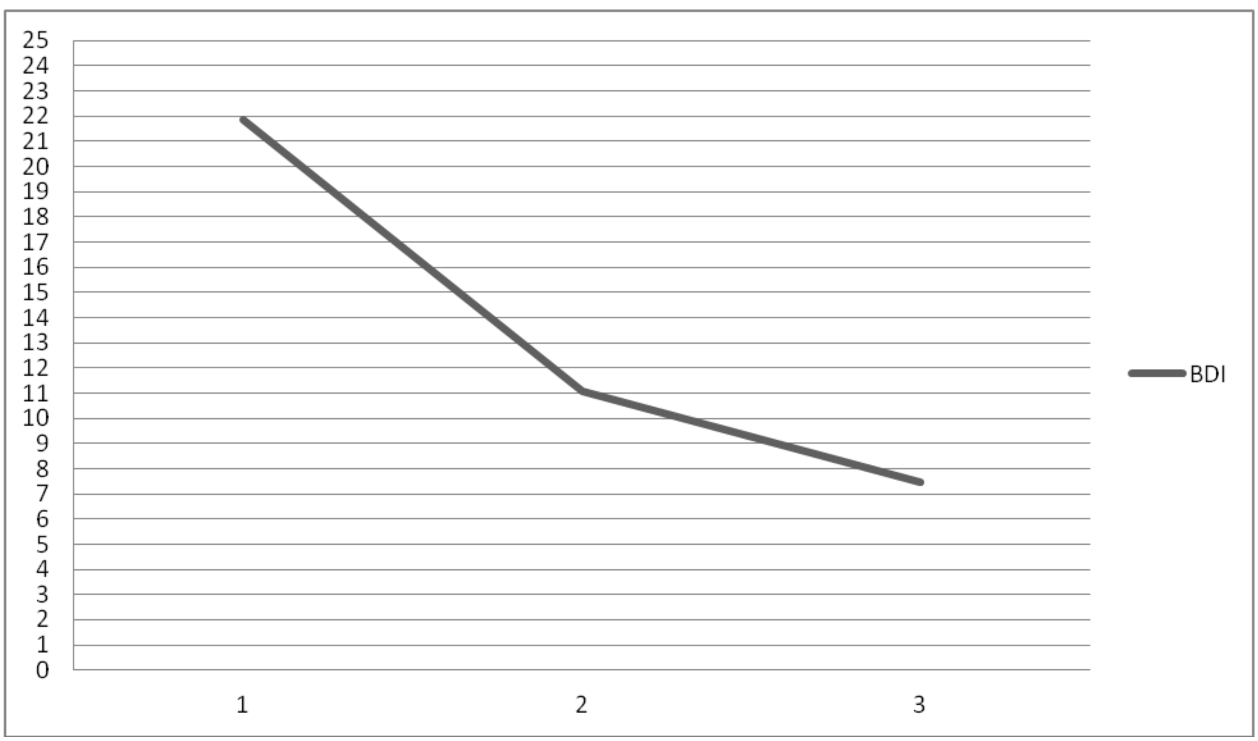

Figure 7. Changes in the means of the PLF Group from testing occasion one to occasion three for the BDI- 2.

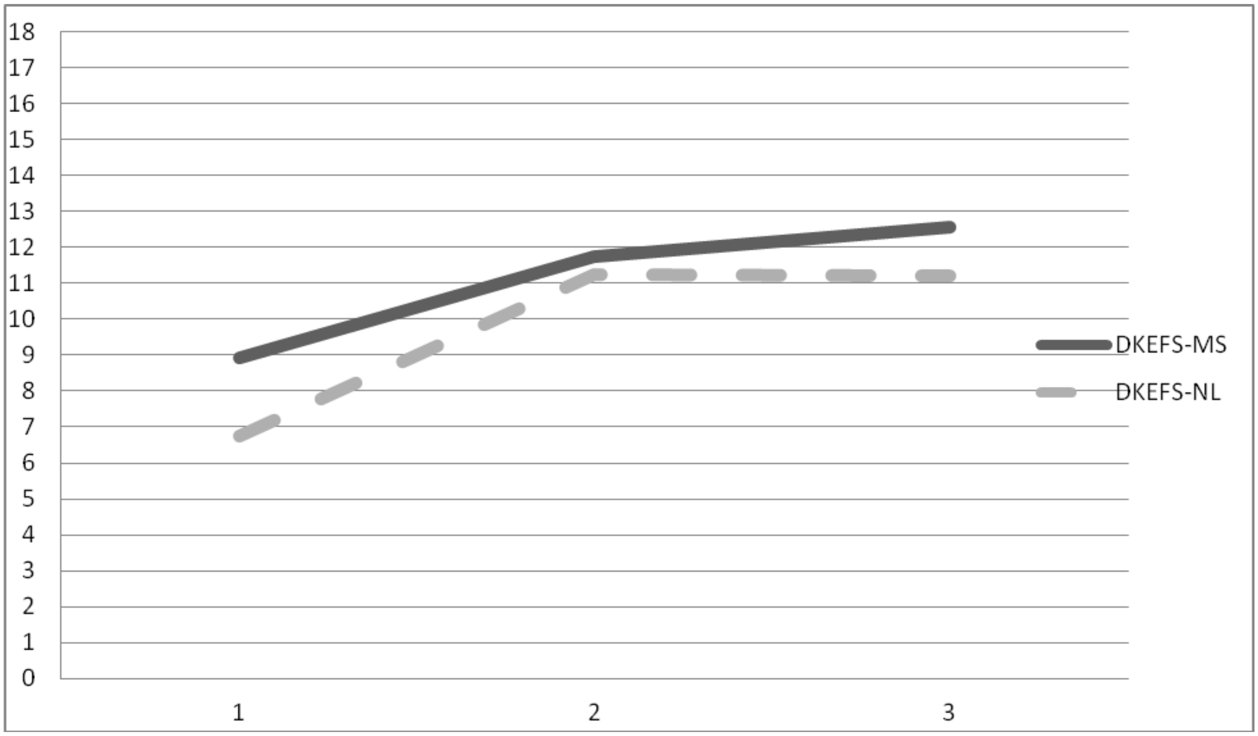

Figure 8. Changes in means in PLF Group from testing occasion one to occasion three for the DKEFS.

The results for patients with Semicircular Canal Dehiscence differed from both the Perilymph Fistula Group and the sample population as a whole. ANOVA revealed a robust effect size (ES = 1.11) which substantiates participants' reports of improved mood from pre-surgical to post-surgical testing occasions in depression; however, changes did not meet a test for significance (BDI-2) (F (1, 4) = 2.24, p <.169); according to Sullivan and Feinn (2012, p. 280), "Unlike significance tests, effect size is independent of sample size.… Sometimes a statistically significant result means only that a huge sample size was used." Additional assessments that demonstrated insignificant p values, but robust effect sizes were: Verbal Memory (F (1, 4) = 4.80, p < .060); Motor Speed (F (1, 4) = 5.09, p < .037); Attention/Concentration (F (1, 4) = 2.14, p < .180); and Number/Letter Switching (F (1, 4) = .94, p < .431). Full Scale IQ (WRIT) (F (1, 4) = .751, p <

.502); Perceptual Memory (*F* (1, 4) = .603, *p* < .570); and Working Memory (*F* (1, 4) = .060, *p* < .944) remained relatively stable (see Table 13).

Table 13

Means, Standard Deviations, and Cohen's d Effect Sizes on Study Measures by Occasion for Participants with Semicircular Canal Dehiscence

Occasions	1		2		3							
	M (n=5)	SD	M	SD	M	SD	Df	F	*p* *a = .05*	ES 1-2	ES 1-3	ES 2-3
BDI-2	18.17	6.91	6.20	6.09	10.33	10.69	1,4	2.24	<.169	1.65	1.11	.20
WRIT	102.00	9.84	108.83	13.98	102.60	19.86	1,4	.751	<.502	.67	.19	.31
WRAML-V	104.33	8.19	108.33	16.44	116.20	16.21	1,4	4.80	<.060	.16	1.17	.78
WRAML-P	109.50	17.12	108.50	12.65	112.40	18.96	1,4	.603	<.570	.20	.36	.21
WRAML-AC	102.33	20.24	96.50	13.07	103.80	20.61	1,4	2.14	<.180	.50	.13	.71
WRAML-WM	112.17	22.44	110.00	16.44	109.40	7.92	1,4	.060	<.944	.01	.11	.14
DKEFS-MS	10.00	1.70	10.77	1.21	11.80	1.10	1,4	5.09	<.037	.60	1.91	1.50
DKEFS-NL	9.83	2.48	10.33	2.16	12.00	1.00	1,4	.94	<.431	.09	.97	1.06

Note: BDI-2 = Beck Depression Inventory, 2nd edition, WRIT = Wide-Range Intelligence Test, WRAML-V = Verbal Memory, WRAML- P=Perceptual/Visual Memory; WRAML A/C = Attention/Concentration; MS = Motor Speed; NL = Number/Letter Switching

Figures 9, 10, and 11 illustrate the changes in means for patients with Semicircular Canal Dehiscence. As seen in Figure 8, Attention/Concentration shows a slight decline in performance initially after surgery (occasion one to two) , but improved from occasion two to occasion three. This kind of post-surgical cognitive decline are familiar in some patient populations (Habets et al., 2014; Santini et al., 2012; Satoer et al., 2015). Conversely, FSIQ demonstrated a slight improvement (from occasion one to two) and decline (from occasion two to three) over the same respective intervals.

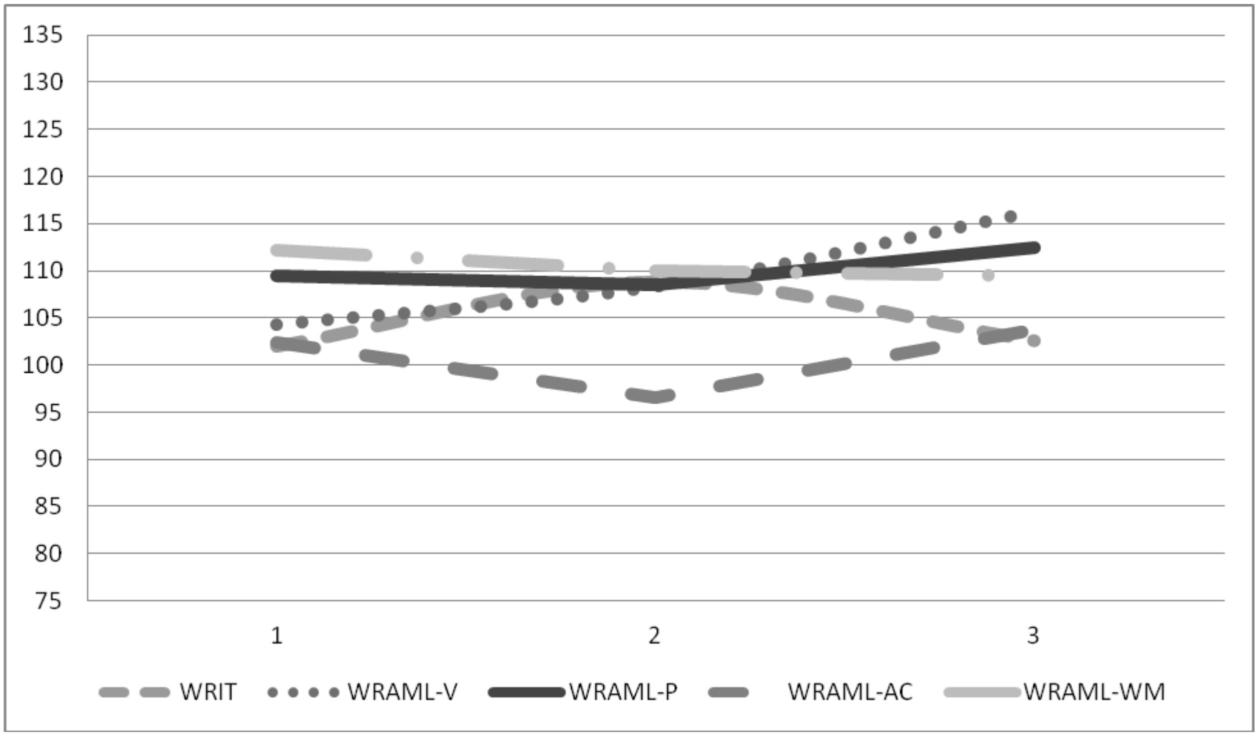

Figure 9. Changes in means of SCD Group from testing occasion one to occasion three for WRIT and WRAML-2.

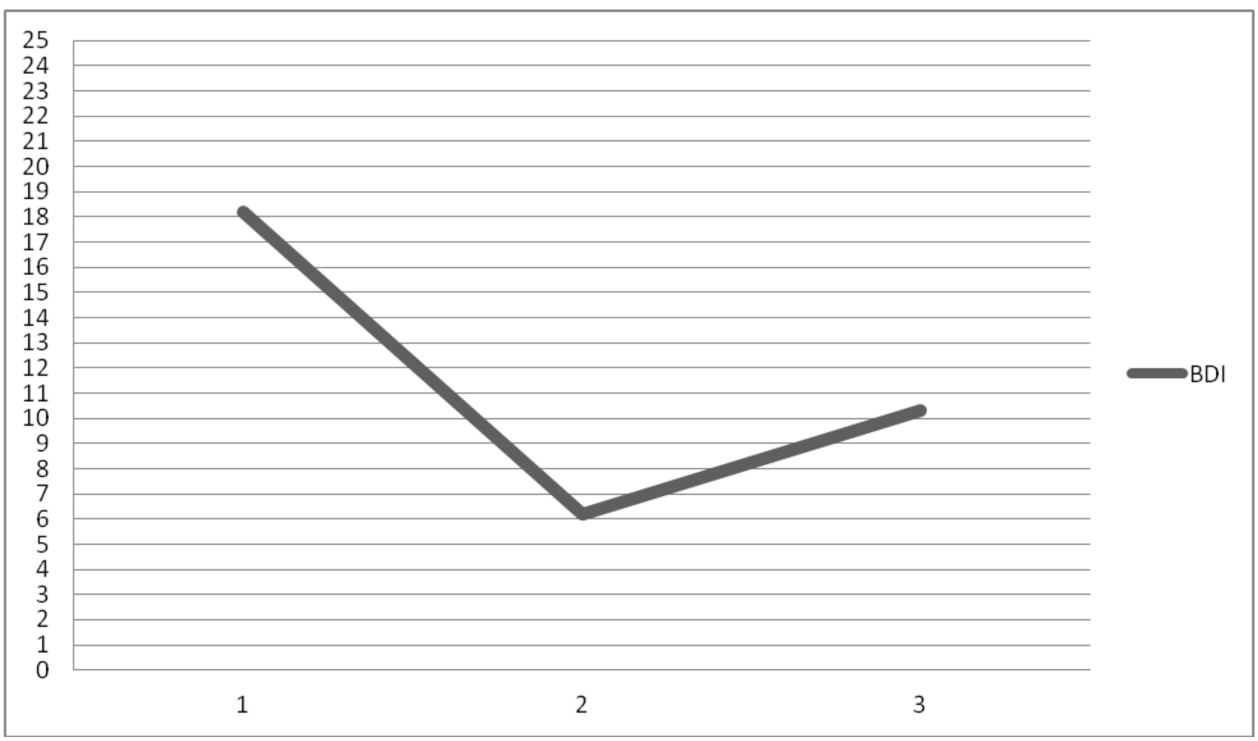

Figure 10, Changes in means of SCD Group from testing occasion one to occasion three for BDI-2.

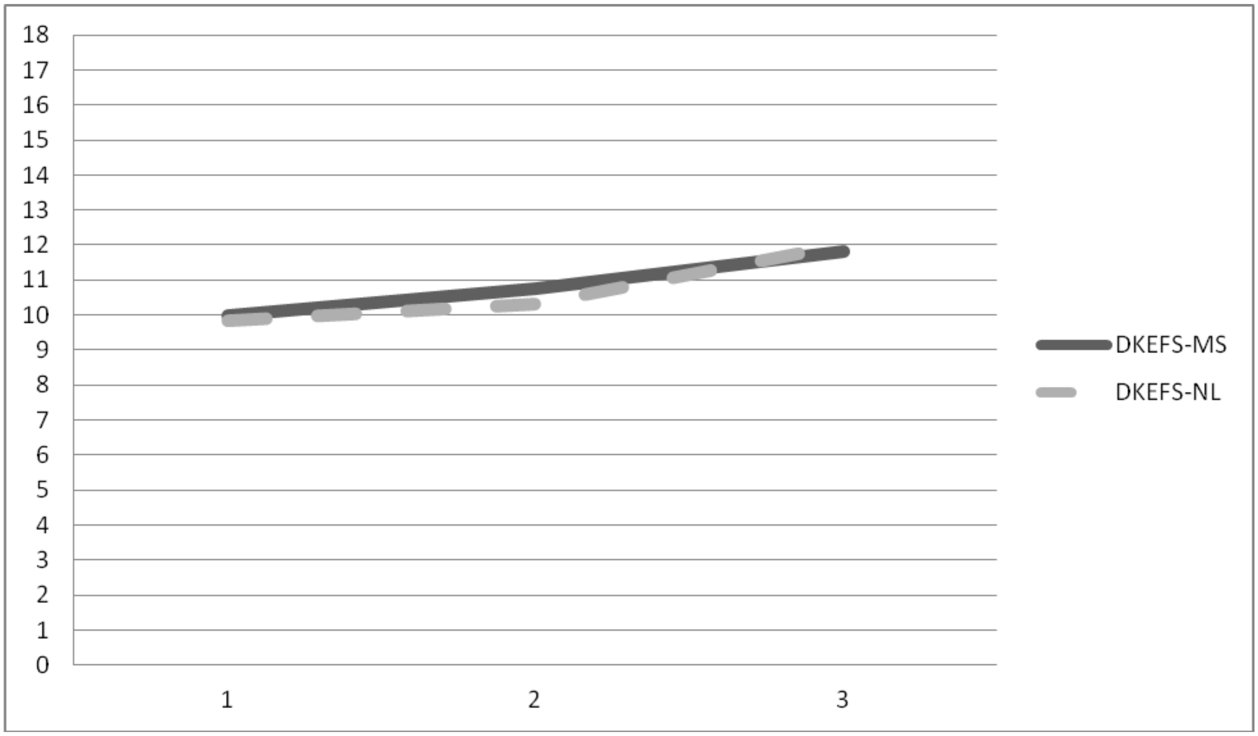

Figure 11. Changes in means of SCD Group from testing occasion one to occasion three for DKEFS.

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Chapter 4

Discussion

The primary objective of this study was to replicate Grimm et al.'s (1989) findings of cognitive inefficiencies in patients diagnosed with Perilymph Fistula. Ancillary to this aim was to explore whether Superior Semicircular Canal Dehiscence patients experience similar cognitive difficulties as well. A secondary objective was to determine if patients' affective and cognitive functioning improved post-surgery for either or both conditions. Participants' cognitive abilities were assessed between one to six weeks prior to surgery to measure present levels of functioning. They were then re-assessed 8-12 weeks post-surgically. Approximately one year post-surgery, a last assessment battery was given to all but four participants; in these cases, results for this study were not obtained within the time allotted. The pragmatic characteristics inherent in medical practice restricted data collection as participants' individual surgery dates differed.

There were differences revealed across several measures contingent on category of otic capsule defect, i.e., PLF or SCD. Patients with PLF appeared to reap the most benefit from surgical intervention as seen in post-operative improvements in all domains. Unfortunately, Grimm et al did not obtain post-operative neuropsychological assessments; comparison data could have provided confirmatory support concerning the benefits of surgery for PLF. Perhaps continued research into cognitive functioning and Perilymph Fistula will provide that support, as well as further specificity, which in turn could help shape future rehabilitation protocols. In the present sample, PLF patients

clearly showed large gains in cognitive functioning following surgery and at follow-up. Mood showed similar large effects.

While there also appear to be cognitive and affective improvement for patients with SCD, there was less dramatic change than that which was seen in the patients with PLF. Analysis of patients with combined PLF/SCD was not realized. Patients in this category of otic capsule defect did report lessening of depressive symptoms post-operatively, while cognitive difficulties tended to persist, or return, post-operatively:

> There may be a genetic component, a weakness, in the otic capsule, whether in the bone and/or the semi-circular canals, in which an individual patient may have one disorder repaired, only to have it recur, or a different one to occur… and we have some outliers, patients who don't improve… the body absorbing the material [used to repair the tear or dehiscence] (P.A.Wackym, personal communication, 2015).

Despite difficulties experienced by patient outliers, taken altogether these results suggest that surgery for otic capsule defect alleviates depression and enhances specific cognitive abilities, e.g., the ability to retrieve rote word lists and more complex verbal messages such as instructions or a brief anecdote. Participants' ability to remember complex visual detail in illustrations, as well as to remember and reproduce arbitrary designs, also showed post-operative improvement. Progress also was seen in participants' ability to attend and concentrate on random information and to quickly change from one task to another. While firm causal conclusions are precluded by the study design, results show clear post-surgical benefits for patients with otic capsule defects, regardless of type.

The most dramatic, statistically significant developments were obtained from the patients in the Perilymph Fistula group. Large effect sizes were observed across all assessment domains from testing occasion one to occasion three. On the whole, gains were equivalent to about 12 to 20 points on WRIT and WRAML-2 subscales, with gains of similar magnitude on the D-KEFS. In contrast, review of meta-analytic studies (1985-2013) of recovery following traumatic insult, e.g., stroke, revealed average effect sizes with (r = .51) and without intervention (r = .31) (Elliot & Parente, 2014); and in another study, short-term improvement in attention/concentration following stroke (g = .67) were noted; however, similar gains were not identified following TBI or CNS malignancy (Virk, Williams, Brunsdon, Suh, & Morrow, 2015). M. J. Ashley (2012, p.4) states, "Emerging evidence suggests that patients with non-TBI brain injury may require different levels and types of stimulus to achieve neural representation." It appears that the pre-operative results obtained from this study are similar to the earlier research of Grimm et al., and as such, may offer the participants a sense of validation of their experience, relief in the knowledge that they are not mentally ill, and may increase earlier access to appropriate treatment for future patients.

There are several factors not as yet discussed. Firstly, it would be remiss to ignore the possible confounding effects of pharmacological management of vestibular symptoms, e.g., vertigo. All of the participants in the study were prescribed diazepam as a vestibular suppressant. Medication was generally taken before and for one month after surgery. As a central nervous system suppressant, diazepam has sedative effect; it may cause drowsiness, and impair concentration and alertness (Mayo Clinic, 2016), and thus slow processing (motor) speed. Addressing the benefits of diazepam as a vestibular suppressant, as well as its possible confounds in cognitive efficiency may clarify future results.

Secondly, patients at the Ear and Skull Base Center choose whether they would like to pursue a vestibular rehabilitation program after recuperation from surgery. Anecdotal reports from patients were mixed, with some patients providing positive endorsement, while others remained unconvinced of its benefits. Adding vestibular rehabilitation to upcoming research as an additional variable, with a matching group of controls who choose not to participate in this activity may provide valuable information regarding rehabilitative practice.

Lastly, as in any psychological assessment battery, there is the possibility that a participant, for any number of reasons, may be malingering. No formal test to detect malingering was given during this study protocol. The Verbal Learning subtest of the WRAML-2 can be paired with the optional Verbal Learning Recognition subtest. A cut score can be then be calculated to detect malingerers from the clinical population. According to Shaver (2004, p.46), "a cut score of -1 appears to provide optimal classification accuracy for discriminating simulators from both TBI patients and non-clinical individuals." As the psychological assessments are performed for research purposes only, they are not subject to subpoena by the court, and at face value, it is unlikely, but not impossible, that patients will malinger. However, if Shaver is correct, it is a simple procedure to determine effort.

To the scientific community, the results of this study may offer additional behavioral validation that Perilymph Fistula is indeed a medical condition, and consequently, may serve to educate physicians about its causes, symptoms, cognitive effects, and treatment. In addition to timing, type and intensity of intervention, Ashley stated, "The brain appears to respond preferentially to combination approaches that include pharmacological, neuroendocrine, dietary [factors] and other adjuvant treatments" (2012, p. 5). Perhaps effort could also be focused on

design of appropriate neurological rehabilitation protocols that could be used in tandem with vestibular rehabilitation activities, as well as monitoring these other physiological processes to provide individualized, comprehensive care.

No controversy surrounds objective diagnosis of Superior Semicircular Canal Dehiscence, yet this is the first study that attempted to examine levels of cognitive functioning in patients with this vestibular disorder. Outcomes were somewhat dissimilar from those of the PLF group. Positive change was not observed from one testing occasion to another in all domains tested as was demonstrated in the PLF group. Sample size may be a limiting factor. However, examination of effect sizes suggests SCD patients may have a different and less robust recovery trajectory than PLF patients. Perhaps these differences may be due to etiology. Semicircular Canal Dehiscence is often organic, due to a developmental abnormality in which an individual is born with a thinning or absent bone spread over the superior canal. Discrete neural connections are made during early development that may compensate for otic capsule dysfunction (Purves, 1988). It is unknown how cognitive functioning will change further as more time goes by. Collection of longitudinal data over a year, two years, or more, may make available information relevant to recovery and rehabilitation for otic capsule defects, as well as other kinds of injuries to the brain.

Corroboration of patients' subjective experiences with objective data may serve to educate patients and the medical community about symptoms, causes, and interventions adapted to the overall well-being of each patient. This research may generate awareness in education and sports concerning symptoms of otic capsule defect, symptoms that on the surface may seem unrelated to traumatic brain injury; this in turn, can lead to medical and psychological referrals for appropriate treatment.

Due to research design, firm causal conclusions are precluded. Data generally supports the conclusion that surgery improves cognitive functioning for the participants with otic capsule defects, but cannot demonstrate causal effects in the absence of an equivalent control group. However, significant gains following surgery for PLF, SCD and PLF/SCD combined type supports the hypothesis that otic capsule defects may cause significant cognitive impairment and that successful surgery can alleviate these symptoms.

According to the Centers for Disease Control "an estimated 5.3 million Americans live with a traumatic brain injury-related disability." In sports, particularly American football,

> 33% of reported concussions occur at practice, and four to five million concussions occur annually, with rising numbers among middle school athletes. As the population of adults aged 65 years or older rapidly increases, so do the risk of falls and head injury.
>
> One out of five falls causes a serious injury, such as broken bones or a head injury; falls are the most common causes of traumatic brain injuries; and adjusted for inflation, the direct medical costs for all fall injuries is $34 billion annually. (CDC, 2016, p. 2)

The Department of the Defense estimates that 82.5% of traumatic brain injuries acquired by military personnel are classified as mild traumatic brain injury (2015). This sort of brain injury is the most common denominator involved in perilymph fistula (Grimm et al., 1989).

At the Ear and Skull Base Center, longitudinal studies involving more comprehensive neuropsychological assessment, a greater number of participants, and including data gathered from fMRI assessing functional connectivity will be conducted under a five-year grant from the National Institutes of Health. Due to the alarming increase in the number of head injuries in

military veterans, as well as in both children and adults participating in amateur and professional sports, it is hoped that this new study, and any in the future, will launch implementations of new strategies for diagnosis, treatment and rehabilitation.

Summary and Conclusion

The present study examined depression and cognitive functioning in two groups of otic capsule patients before and twice following surgical repairs. Results for PLF patients showed significant and sustained reductions in depression and significant gains in all areas of cognitive functioning assessed. Effect sizes were large; cognitive gains were sustained and further gains were shown in several domains during the six-nine month follow-up period. For SCD patients, significant reductions in depression were also noted. However, cognitive gains were less consistently found, smaller, and more varied in degree, and tended to be more delayed than for the PLF group. These data are consistent with the hypothesis that PLF, and perhaps SCD, cause cognitive impairment and that surgical intervention can reverse these effects.

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Appendix A

Patient Videos

Right perilymph fistula not superior canal dehiscence. Patient video describing symptoms before and after surgical repair. https://www.youtube.com/watch?v=bDph0B0uLbg (Accessed March 27, 2015). Copyright © Ear and Skull Base Center, used with permission.

Right perilymph fistula: dizziness, migraine headaches and cognitive dysfunction. Patient video describing symptoms before and after surgical repair. https://www.youtube.com/watch?v=ETjsJocMBYk (Accessed March 27, 2015). Copyright © Ear and Skull Base Center, used with permission.

Perilymph fistula. Patient video describing symptoms before and after repair of traumatic perilymph fistulae. https://www.youtube.com/watch?v=jSAM6h-7Mwc (Accessed March 27, 2015). Copyright © Ear and Skull Base Center, used with permission.

Appendix B

Curriculum Vitae

Heather Mackay, MEd, PSYD

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Saint Helens, OR 97051
503-853-4060
hmackay09@georgefox.edu

EDUCATION

George Fox University
Newberg, Oregon

Doctoral Student Clinical Psychology 2009-present

- Doctoral degree 2015
- Master's degree 2011

Dissertation: Outcome of surgery on neurocognitive functioning in patients with otic capsule defects

Abbreviated Abstract: Patients who have a tear in one of their semi-circular canals or thinning of the bone above, experience difficulty maintaining postural control and balance; they may feel dizzy and nauseous; and often demonstrate persistent cognitive symptoms in a manner similar to individuals who have suffered a traumatic brain injury. However, patients who have a perilymph fistula exhibit additional symptoms unconnected to those typically seen in a head injury that are commonly diagnosed as a psychopathology. A perilymph fistula cannot be seen on MRI, making diagnosis difficult. Cognitive improvements after surgical repair of perilymph fistulae may be seen as authentication of this aspect of the disorder; in turn can lessen patients' subjective distress as well as augment rehabilitation.

Lewis and Clark College
Portland, Oregon

M.Ed. Special Education Deaf/Hard of Hearing

Thesis: Classroom Discourse and the Mother-Child Conversational Dyad: Implications for School Success with Deaf/Hard of Hearing Children

Abbreviated Abstract: The reciprocal communication between a mother and her infant is not mirrored in modern day classrooms. In general, a typical hearing child, without developmental delay, learning disability, or other form of cognitive injury, is usually able to adapt to an

environment where the teacher talks to the class without expectation of response from the students. A deaf/hard of hearing child whose receptive and expressive language is thus delayed, may find the communicative shift from dyadic to monologic a bewildering experience. Is the impact of this communicative variation enough to warrant a departure from current educational methodologies?

San Diego State University
San Diego, California

B.A. Speech Pathology/Audiology

SUPERVISED CLINICAL EXPERIENCE

Legacy Research Institute 2015-present
Portland, Oregon

Post-Doctoral Research Fellow
Supervisor:
Lauren Whitelaw, Psy.D.
Clinic Director and Vice President of Research:
P. Ashley Wackym, M.D.

- Provide pre and post-operative neuropsychological assessments for patients experiencing vestibular disorders at the Ear and Skull Base Center, an adjunct clinic of Legacy Research Institute. Responsible for scoring protocols, interpreting results, and report writing, as well as maintaining participant scoring database in preparation for statistical analysis. Traveling when necessary to generate timely, accurate results.
    - Wechsler Adult Intelligence Scale, 4th Ed. (WAIS IV)
    - Wide Range Assessment of Memory and Learning, 2nd Ed. (WRAML2)
    - Millon Behavioral Medicine Diagnostic (MBMD)
    - Patient Health Questionnaire (PHQ-9)
    - General Anxiety Disorder (GAD-7)
    - Pain Catastrophizing Scale (PCS)
    - Adverse Childhood Experiences Scale (ACES)
    - Resilience/Stress Questionnaire
    - Dizziness Handicap Inventory (DHI)
    - Headache Impact Test (HIT 6)
    - Tinnitus Functional Index (TFI)
- Participate in research study design; IRB protocol development; grant writing; and implementation of studies assessing cognitive and psychosocial functioning in individuals with vestibular disorders, specifically otic capsule dehiscence, migraine, traumatic brain injury, as well as any co-morbidities. Maintain correspondence with patients involved in research studies.

- Collaborate with both internal and external investigators and healthcare professionals in obtaining imaging data and analysis (MRI, DTI – fractional anistropy); CSF flow studies, volume and protein assay; surgical intervention; and literature reviews.

- Produce video *Yoga for Vestibular Disorders*; distribute via the Vestibular Disorders Association (VEDA: http://vestibular.org/)

- Lead psychoeducational group "You are not your Dizziness", using an eight-week mindfulness curriculum; provide supportive counseling, outside resources and referrals as needed.

- Consult with Serene Perkins, M.D., Director of Surgical Program at **Legacy** Institute for Surgical Education and Innovation (LISEI) on her study in association with the Children's Cancer Association, *The effect of music therapy on post-operative children and use of opioids and anxiolytics (in press)*.

- Participate in *Legacy Research Career Development Course* taught by Detlev Boison, Ph.D., Dow Chair of Neurology & Director of Neurobiology Research

- Engage in *Collaborative Institutional Training Initiative* (CITI) courses focused on human subjects research (HSR) protections: Human Subjects Research I & II (HSR); and IRB Administration.

- Member at Large of Legacy Research Institute Good Health Committee for employee wellbeing.

HealthPoint Community Healthcare Clinic 2014-2015
Seattle/Tacoma, Washington

Intern
Supervisors:
Sierra Swing-Kent, Psy.D. & Jim Berghuis, Ph.D.

- Participate in an urban, population-based, medical home model of integrated behavioral primary care setting, providing services and interventions to a culturally rich and diverse patient population, experiencing a wide range of physical and mental health concerns

- Conduct intake interviews, diagnose and conceptualize cases, plan interventions for individuals and families, ranging in age 3 to 75 years, from an underserved, urban population integrating Cognitive Behavioral Therapy, Dialectical Behavioral Therapy, Mindfulness, and Interpersonal Therapy within a brief, 6-8 week, format

- Collaborate and coordinate care, actively participating in team hand-offs, with an interdisciplinary team of physicians, physician assistants, naturopathic and osteopathic physicians, psychiatric nurse practitioners, nurses, patient navigators and referral coordinators, various other support staff, and when appropriate, family members.

- Provide accurate diagnoses to assist with appropriate prescription of psychiatric medications by physicians

- Provide culturally sensitive intervention for refugee and asylee patients from many different nations; partner with face-to-face, computer and phone access interpreters to ensure expressive and receptive communication accuracy

- Crisis intervention; threat and suicide risk assessment

- Create referrals and coordinate with outside agencies, community mental health facilities, chemical dependency centers, as well as school districts

- Provide ADHD, ASD and Cognitive screens to determine appropriate referrals

    - Brown ADD Rating Scales for Children, Adolescents and Adults
    - Comprehensive Trail Making Test (CTMT)
    - Montreal Cognitive Assessment (MoCA)
    - Modified Checklist for Autism in Toddlers, Revised with Follow-Up (MCHAT)
    - Pediatric Symptom Checklist-17 (PSC-17)

- Co-Lead *A Year of Being Well* and Diabetes Management Groups with the HealthPoint nutritionist. Each module is year-long, provided in one hour blocks monthly for both English and Spanish speaking patients and their families, ages 12-75

- Supervision: 2 hours/week individual; 2 hours/week group; and day to day, impromptu consultation as needed

- Didactics: twice monthly meetings. Topics are varied and reflect patient demographics, and include topics such as, Cultural Competence with refugees; Diabetes; Obesity; Biofeedback; Drug/ETOH problems assessment and resources; ADHD in adults and children; Depression and Suicide Risk Assessment; Parenting Techniques and Management of common behavioral Issues in children and adolescents; Anxiety disorders and interventions; Chronic Pain and Controlled Substances; Hyperlipidemia management; PTSD, stress related illnesses and psychoneuroimmunology; DBT Skills Training; ACT; Bereavement and grief counseling

Oregon Health & Science University 2013-2014
Richmond Family Medicine
Portland, Oregon

Pre-Intern
Supervisor:
Tamara L. Hoogestraat, Psy.D.

- Understand and effectively participate in the medical home model of integrated care in a primary care organization

- Conduct intake interviews, diagnose and conceptualize cases, plan interventions for individuals and families, ranging in age 6 to 75 years, from an underserved, urban population integrating Cognitive Behavioral Therapy, Dialectical Behavioral Therapy, Mindfulness, and Interpersonal Therapy

- Collaborate and coordinate care with and interdisciplinary team of physicians, physician assistants, psychiatric nurse practitioners, nurses, social workers, support staff, and when appropriate, family members

- Crisis intervention, threat and suicide risk assessment

- Participate in Warm Hand-Offs

- Lead Dialectical Behavioral Skills Group with the Social Work team of Richmond Family Medicine. Each module is six weeks long, conducted in two hour blocks one day per week for patients who are participating in individual therapy, with a variety of psychological diagnoses, ages 18-75

- Perform cognitive assessments:
    - Wechsler Adult Intelligence Scales, 4th Ed. (WAIS IV)
    - Personality Assessment Inventory (PAI)
    - Conners Adult ADHD Rating Scales (CAARS)

- Perform pre-surgical bariatric assessments:
    - Personality Assessment Inventory (PAI)
    - Health Locus of Control Scale (HLCS)
    - Beck Anxiety Inventory (BAI)
    - Alcohol Use Disorders Identification Test (AUDIT)
    - Binge Eating Scale (BES)
    - Weight and Lifestyle Inventory (WALI)

- Supervision: 1 hour/week individual; 1 hour/week group; and day to day, impromptu consultation as needed

Ear and Skull Base Center/Legacy Research Institute 2012-2014
Portland, Oregon

Practicum II
Supervisors:
Rodger Bufford, Ph.D., P. Ashley Wackym, M.D., Jennifer Ratigan, Au.D.

- Program development and implementation of a neurocognitive assessment battery designed to meet the needs of the Ear and Skull Base clinic and the patient population it serves; create administrative documents, e.g., Informed Consent, Release of Information; administered assessments and interpreted results to patients and interdisciplinary team

- Understand the administrative structure of a busy medical clinic, including day to day operations, delivery of services within a medical model, collaboration with interdisciplinary teams and support staff, funding, and relationship to the research facility and its relationship to the community

- Perform intake interviews, plan treatment for individuals coping with vestibular disorders, adjusting to the diagnosis of hearing loss, and the related effects both personally and professionally

- Perform and interpret neuropsychological assessments:

  - Wide Range Intelligence Test (WRIT)
  - Wide Range Assessment of Memory and Learning, 2nd Ed. (WRAML-2)
  - Delis Kaplan Executive Function System
  - Beck Depression Inventory 2nd Ed. (BDI II)
  - Beck Anxiety Inventory (BAI)
  - Perilymph Fistula Scale (developed in collaboration with Rodger Bufford, Ph.D., a Likert-type subjective experience, self-report measure)

- Integrate Interpersonal Therapy and Cognitive Behavioral Therapy for individual counseling; for both individual and family, provide psycho-educational materials and resources concerning peer support, assistive listening technologies, and sources of financial support for amplification

- Design a neuropsychological rehabilitation protocol that complements the vestibular rehabilitation already in place (in process)

- Active participation in research in collaboration with P. Ashley Wackym, M.D., Jennifer Ratigan, Au.D., and Carey Balaban, Ph.D.

- Supervision: 1 hour/week individual supervision with Rodger Bufford, Ph.D., as well as day to day supervision with P. Ashley Wackym, M.D. and Jennifer Ratigan, Au.D.

Parent Advice Line 2011-2012
George Fox University Behavioral Health Clinic
Supervisor: Joel Gregor, Psy.D.

- Answer telephone queries in the evenings from parents regarding their children's development

- Provide behavioral interventions, and psycho-educational materials and resources to obtain additional support if necessary

Rural School District Consortium 2010-2011
Yamhill and Carlton, Oregon

Practicum I
Supervisors:
Elizabeth Hamilton, Ph.D.; Gene Bundy, M.S.W.

- Provide counseling services to a diverse student population in a rural school setting, ranging in grade level from elementary through high school
- Conduct intake interviews, diagnosis and treatment planning for individuals and families, integrating Cognitive Behavioral Therapy, Solution-focused Therapy, and Systems Therapy
- Crisis intervention, threat assessment, and suicide risk assessment
- Understand the administrative structure of school systems, the day to day operations, regular education curricula and methods, special education law and delivery of services, the various support services, funding, and relationship to the community
- Perform and interpret cognitive, behavioral, and projective assessments:
    - Woodcock-Johnson III Tests of Cognitive Abilities and Achievement (W-J III)
    - Wechsler Intelligence Scale for Children, 4th Ed (WISC IV)
    - Wechsler Individual Achievement Test, 2nd Ed (WIAT II)
    - Wide Range Assessment of Memory and Learning, 2nd Ed (WRAM-L 2)
    - Behavior Rating Inventory of Executive Function (BRIEF)
    - Peabody Picture Vocabulary Test, 4th Ed (PPVT-4)
    - Behavioral Assessment System for Children, 2nd Ed (BASC-2)
    - Vineland Adaptive Behavior Scales, 2nd Ed (Vineland II)
    - The Rorschach Test
    - House-Tree-Person Test
    - Robertson's Apperception Test
- Provide integrated, comprehensive psycho-educational reports to administration, staff, and parents, including interpretation of assessment results in concert with GPA and the Oregon Assessment of Knowledge and Skills (OAKS), diagnoses, and recommendations
- Collaborate with interdisciplinary teams at IEP meetings to establish present levels of development, establish goals and objectives, and determine delivery of services
- Supervision: 2 hours weekly of group supervision; 1 or more hour (s) individual supervision

George Fox University Counseling Practicum Spring 2010

Pre-practicum
Supervisors:
Ken Kornelis, PhD; Todd S. Hilmes, M.A.; and Danielle Morgan, M.A.

- Provide outpatient services to volunteer female and male undergraduate students
- Conduct intake interviews, diagnosis, treatment planning, and individual psychotherapy
- Responsibilities include report writing, case presentations, and consultation with both supervisors and clinical teams
- All sessions are taped and reviewed by supervisors
- 2 hours of weekly supervision: 1-hour group, 1-hour individual

TEACHING EXPERIENCE

Master teacher 2006-2009

Groner Elementary School
Hillsboro, Oregon

- Cultivate a relationship of mutual respect and safety
- Mentor student teacher intern from Portland State University in the nuances of teaching day to day, i.e., problem solving, trouble shooting, and increasing self-reflection within a specialized instruction, public school setting
- Facilitate the development of a professional identity and integrity, as well as competency in both the technical and interpersonal dimensions involved in a professional career in education

Northwest Regional Educational Service District 2005-2009
Hillsboro, Oregon

Classroom Teacher Deaf/Hard of Hearing Early Childhood Intervention

- Design and implement specialized, developmental and sequential instruction empirically based on the research of Ling, Simser, and Estabrooks, utilizing the Storybook Curriculum as external framework for the Deaf/Hard of Hearing Auditory/Verbal Preschool and the Dual Language Preschool for students 3 to 5 years of age
- Smoothly integrate an equal number of typical student peers; with hearing and cognitive abilities typical for children 3 to 5 years of age
- Collaborate with Interdisciplinary Teams consisting of speech language pathologists, audiologists, occupational therapists, physical therapists, and so on to assess current levels of development; establish individual goals and objectives; and determine placement within the least restrictive environment

- Co-Leader of Family Education Group established to encourage communication with other families who have young children with hearing loss. Provide information concerning the impact of hearing loss on speech/language/listening/social development; communication options; strategies for use at home to optimize development of these skills; types of amplification and benefits of amplification; advocacy; and additional resources, agencies and organizations available for the hearing impaired

- Case Manager for students, conduct IEP meetings, and coordination of services with Speech/Language Pathologists, Audiologists, Occupational Therapists, Physical Therapists, and other Early Childhood Specialists

- Supervise ASL Specialist, ASL Paraprofessionals, and Instructional Assistants

- Perform and interpret developmental assessments:

    - Brigance Early Childhood Developmental Inventory
    - Preschool Language Scale Screening Test, 4th Ed. (PLS 4)
    - Speech Perception Instructional Curriculum and Evaluation (SPICE)

SUPERVISORY EXPERIENCE

Supervision of 2nd year student 2013-2014

Newberg, Oregon

- Model and cultivate a relationship of integrity and trust in which expectations and roles are clearly defined, and communication is conducted with mutual respect and conflict is managed in a constructive manner

- Facilitate the development of the student's professional identity and career trajectory

- Assist the student in navigating the nuances of being a graduate student in clinical psychology at George Fox University, e.g., finding and applying for research grants and supplemental research projects; determining future practicum sites that align with career goals; ensuring self-care, and so on

RESEARCH EXPERIENCE

- ***Research Vertical Team***: 2010-2014

  George Fox University
  Advisor: Rodger K. Bufford, Ph.D.

  Participate in bi-monthly meetings with the research team advisor and students from each year of the program for consultation regarding dissertation progress as well as collaboration on supplemental research projects

- ***Research Assistant***:
  George Fox University

Supervisor: Heather Paige-Deming, M.A.

Administer WRAML-2 to adult volunteers as part of data collection for a study assessing the memory implications of mild to moderate hearing loss

- ***Dissertation***:
  George Fox University
  Rodger K. Bufford, PhD

  Outcome of Surgery on Neurocognitive Functioning in Patients with Otic Capsule Defects (in process)

- ***Thesis***:
  Lewis and Clark College
  Barbara Schirmer, PhD

  Classroom Discourse and the Mother-Child Conversational Dyad: Implications for School Success with Deaf/Hard of Hearing Children (1992)

PRESENTATIONS

- Wackym, P., Mackay, H., & Balaban, C. (2015, in process) Cognitive and Neurobehavioral Consequences of Otic Capsule Defects. Paper to be presented at: American Neurotology Society Annual Meeting, Las Vegas, NV

- Ford, D. & Mackay, H. (November, 2013) Sensori-motor Approach to Healing Trauma. Forum Presentation for OHSU faculty at: Portland, OR.

- Mackay, H., Gann-Ryan, J., McGurl, C., & Modrell, J. (August, 2013) These Things Don't Work Themselves: Cochlear Implant Recipients' Rehabilitation and Quality of Life. Poster accepted for presentation at: APA, Honolulu, HI

- Wackym, P. & Mackay, H. (September, 2013) Cognitive and Neurobehavioral Consequences of Pediatric Otic Capsule Defects. Paper presented at: AAO-HNSF Annual Meeting & OTO EXPO, Vancouver, B.C.

PROFESSIONAL DEVELOPMENT

Independent Special Study:
Supervisor:
Rodger K. Bufford, Ph.D.

Neurological Rehabilitation in Concert with Vestibular Rehabilitation

- Research, design, and conduct a pilot implementation of a neurological rehabilitation protocol to complement vestibular rehabilitation. Patients who participated in vestibular therapy have demonstrated improvements in maintaining postural control and balance more quickly than those who do not. Similar gains may be possible for short term

memory, problem solving, attention, processing speed, and cognitive flexibility for patients who participate in an analogous neurological rehabilitation program, which includes additional skill building in both DBT and ACT methodologies.

- Research and design an Android APP from which social workers, graduate students of clinical psychology, and patients themselves can easily access a variety of community resources available within the catchment area of OHSU Richmond Family Medicine in Portland, Oregon.

Assessment Development:

2013 Annual Northwest Assessment Conference

- Using Tests of Effort in a Psychological Assessment
  Paul Green Ph.D.

- Assessing Mild Cognitive Impairment and Dementia
  Mark Bondi, Ph.D., ABPP/CN

Clinical Skills Development:

- Participate in seminar entitled *Exploring the Landscape of Disability Justice: From Lived Experience to Policy and Professional Response* with Hobie Blackhorn, Roberta Dunn, Bud Feuless, Janie March, and Christine Shank, J.D., Lewis and Clark College Graduate School of Education and Counseling, November 2016.

LICENSING

Oregon Basic Teaching License, Standard Hearing Impaired, PreK-12 #34767

PROFESSIONAL AFFILIATIONS

Board Member HEART: www.heartnonprofit.org 2011-present

- Founded organization with a parent of a deaf/hard of hearing child and professionals working in communication disorders, i.e., teachers of the deaf/hard of hearing, speech language pathologists, audiologists, American Sign Language interpreters, and Spanish language interpreters

- Our mission is dedicated to providing hearing healthcare and education, communication solutions and technology resources to both children and adults with hearing loss and other communication disabilities

- Collaborate with other nonprofit organizations to deliver services to individuals and families with hearing loss and other communication disabilities

- Serve as Grant Committee Co-Chair

- Fundraising event planning:
  Maximizing Auditory Potential through Learning and Technology with Jane Madell, Ph.D., Director of Pediatric Audiology Consulting in New York City; former Director of the Hearing and Learning Center of the New York Eye & Ear Infirmary, and co-director of Cochlear Implant Center

Alexander Graham Bell Association	2006-present
Member Oregon Academy of Audiology	2016-present
Member Oregon Psychological Association	2016-present
Member of Association for Contextual Behavioral Science	2016-present

REFERENCES

Rodger K. Bufford, Ph.D.
Professor of Psychology
Graduate Department Clinical Psychology
George Fox University
414 N. Meridian Street V104
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P. Ashley Wackym, M.D.
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Sierra Swing-Kent, Psy.D.
Licensed Clinical Psychologist
HealthPoint Community Healthcare
26401 Pacific Highway South
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Laurie Harrison, Ed.D.
Coordinator
Deaf/Hard of Hearing Program
Northwest Regional ESD
5825 N.E. Ray Circle
Hillsboro, OR 97124
lharrison@nwresd.k12.or.us

Lauren Whitelaw, C.Psychol., Psy.D.
Clinical Supervisor Clinical Psychologist
Licensed Clinical Psychologist
Wide Mind Full
1224 SW Morrison Street
Portland, OR 9720
lauren.whitelaw@widemindfull.com