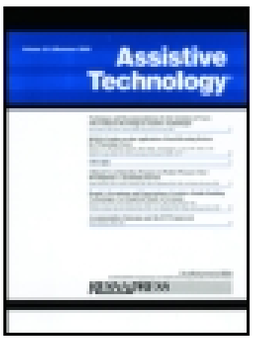

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Self-Reported Assistive Technology Outcomes and Personal Characteristics in College Students with Less-Apparent Disabilities

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Abstract

The impact of assistive technology (AT) services for college students with less-apparent disabilities is under-reported. Using the Canadian Occupational Performance Measure (COPM), we assessed student *Performance* and *Satisfaction* ratings of common academic tasks at the start and end of a semester during which 105 student-clients with less-apparent disabilities received AT services. We examined if COPM initial and change scores related to personal characteristics of gender, class-level (e.g., Sophomore), and STEM education; if personal characteristics predicted a student's follow-through with an AT service referral (n=231); and if personal characteristics and initial COPM scores predicted dropout from AT services (n=187). COPM

ratings significantly increased in all common academic tasks ($p<.001$). Gender predicted initial *Satisfaction* (male ratings > female ratings, $p=.01$). Gender also predicted *Performance* changes, with females being more likely to have a service-meaningful change ($p=.02$). Higher class-level predicted better follow-through with a referral for AT services ($p=.006$). Increasing class-level ($p=.05$) and higher initial studying ($p<.006$) and reading ($p<.029$) ratings predicted a lower likelihood for dropout. These findings demonstrate that college students with less-apparent disabilities experience substantial improvements in their self-ratings of academic performance and satisfaction following AT services. Gender, class-level, and initial self-perceived reading and studying abilities may influence if and how the student participates with AT services.

Introduction

The number of students with disabilities at U.S. colleges and universities continues to increase, with approximately 11% of all post-secondary students reporting one or more disabilities (Snyder, de Brey, & Dillow, 2016). In fact, the actual proportion of post-secondary students with disabilities is much higher, as evidence shows that a sizeable number do not self-identify their disability due to fear of stigma (Kurth & Mellard, 2006), inadequate transition planning from secondary to post-secondary education settings (Newman & Madaus, 2015), or limitations in a student's self-determination to seek out resources (Wehmeyer & Garner, 2003). Despite the growth of the student body with disabilities, these individuals continue to have a much lower retention rate than their student-peers without disabilities. In fact, post-secondary

graduation rates are nearly 20% lower for students with disabilities, hovering somewhere around 35% (Newman et al., 2011).

Presently, U.S. institutions of post-secondary education are legally required to provide students with learning accommodations that enable equivalent access to educational opportunities as mandated by the ADA and Section 504 of the Rehabilitation Act. These accommodations include auxiliary aids in the form of assistive technology (AT) services for students who demonstrate a need for devices, equipment, or software to increase their access to learning materials and activities. According to a National Center for Education Statistics report, 70% of degree-granting post-secondary institutions report AT as a core support to meet the needs of students with a disability (Snyder et al., 2016). Additionally, faculty are increasingly delivering content in electronic formats (Schmid et al., 2014), which is raising the demand amongst students with disabilities to have access to AT tools that allow them to successfully interact with digital content (Seale, 2014). Given that the number of students with a disability on college campuses continues to increase (Snyder et al., 2016), that the delivery of learning content and activities is becoming more digitally grounded, and the rapid growth of software, hardware, and mobile technologies (Brynjolfsson, 2014), AT solutions and universally designed mainstream technology for educational needs will presumably continue to expand as a primary accommodation to ensure access to learning materials, content, and activities.

Many factors may contribute to the academic success of a post-secondary student who has a disability, with AT services being just one component. However, the impact of this component is not well-understood. Recent research demonstrates that post-secondary students benefit from use of a specific technology (e.g., a reading pen) (Schmitt, McCallum, Hennessey, Lovelace, & Hawkins, 2012). Yet, general AT service delivery is necessarily very student-

specific and therefore involves the use of many different AT services or accommodations within and across students. A review of the literature reveals that little has been published about the broad results of mandated AT service delivery in post-secondary institutions, which involves multiple and varied types of AT accommodations and supports. Additionally, more information is needed on how student characteristics might affect the outcome of AT services. This is especially true for college students who have a less-apparent disability. A less-apparent disability is one that has few if any visible characteristics, is often not recognized by others with whom the person interacts in everyday life (von Schrader, Malzer, & Bruyère, 2014), and includes learning disability, attention deficit disorders, and autism spectrum disorders – disabilities that are formally defined by the ADA. Although the 2008 Americans with Disabilities Act Amendment Act (ADAAA) increased the accommodations coverage for individuals with less-apparent disabilities (Burke, Friedl, & Rigler, 2010), post-secondary students with less-apparent disabilities are less likely to receive accommodations than their peers who have a very visually-apparent disability. For example, Newman et al. (2015) found that post-secondary students with apparent disabilities, such as hearing-, vision-, or orthopedic-related disabilities were more likely than those with less-visible disabilities (e.g., learning disability) to receive accommodations (Newman & Madaus, 2015). This may explain why limited information exists about the impact of AT services for individuals who have less-apparent disabilities. We have also found that the appropriate AT accommodations for those with less-apparent disabilities can require more trial-and-error training and can be less prescribed than apparent disabilities. Beyond the less "visually obvious" presentation of less-apparent disabilities, additional factors present challenges to conducting research within this population of post-secondary students. These individuals are often less likely to self-identify their disability;

are less likely to recognize a need for learning accommodations such as AT supports and services (especially if they were not exposed to AT in K-12 education) (Newman & Madaus, 2015); and experience challenges in self-determination to seek out assistance, to follow through with a referral for AT services and accommodations, or are possibly more likely to dropout from services. Further, fear of stigma (Kurth & Mellard, 2006) and a social bias toward physically obvious disabilities (e.g., limb loss, movement deficits due to brain injury, etc.) as 'true disabilities' may discourage a student with a less-apparent disability to disclose her or his problems and needs (Quinn & Earnshaw, 2011).

Personal characteristics may influence the outcomes for supportive services. For example, within the general population of college students, women are more prevalent and have higher graduation rates than their male counterparts (Buchmann & DiPrete, 2006). A range of variables may explain this gender difference in favor of women, such as differences in college preparation, labor market opportunities, anticipated difficulties in repaying college debt, family background, and well-established female advantage in academic performance (Buchmann & DiPrete, 2006; Dwyer, Hodson, & McCloud, 2013). A previous study on AT service outcomes revealed no difference between female and male students with disabilities (Malcolm & Roll, 2017a), however, the study did not present outcomes specifically for students with less-apparent disabilities. How gender interacts with specific disability categories (e.g., less-apparent) to affect the AT service outcomes in college students, has not been described and may be important to the timing and approach of services.

Previous work suggests that the first 2 years of post-secondary education (at 4-year institutions) are especially challenging for students with disabilities, given that the academic expectations and learning environments are substantially different than what the individual

experienced in her/his secondary education (Shepler & Woosley, 2012; Wolf, 2001). Such contextual challenges likely relate to lower college retention rates for students with disabilities, especially in the earlier college years (Wessel, Jones, Markle, & Westfall, 2009). A recent study found that the population of students served favored greater numbers of Freshman and Sophomores (Malcolm & Roll, 2017a), but the authors did not explore the extent to which AT service results differed between all class-levels (Freshman, Sophomore, Junior, Senior, Graduate) in students with less-apparent disabilities. Such an analysis of class-level data may reveal a particular need to reach out to students with less-apparent disabilities who are in their earlier college years, and may demonstrate unique AT service-needs for this population.

Whether or not a student is enrolled in a science, technology, engineering, or math (STEM) major is a final personal characteristic that may relate to AT service outcomes. Owing to accessibility barriers, students with disabilities have historically been excluded from post-secondary STEM education (Moon, Todd, Morton, & Ivey, 2012). Previous research has shown that students with disabilities enrolled in STEM majors have more complex needs for accommodations than non-STEM majors (Moon et al., 2012). Accordingly, STEM instructors may often be unable or unprepared to recognize and support the needs of students with disabilities. AT service professionals may similarly experience challenges in accommodating students with disabilities, as the AT to increase access to scientific literature and notations inherent in STEM education is less available than AT for non-STEM content. Despite these known issues with AT and STEM education, published data are sparse regarding the effect of a student's major (STEM or non-STEM) on the actual results of AT services.

Despite any personal and social barriers experienced when seeking out AT services, students with less-apparent disabilities represent an overwhelming majority of post-secondary

students who end up receiving AT supports. A recent report of data collected by the National Center for Education Statistics (Raue & Lewis, 2011) suggests that students with less-apparent disabilities comprise 71% of the total population of students who self-identify at least one disability. We have likewise confirmed that approximately 75% of AT service-recipients at our university have a less-apparent disability. With more post-secondary students presenting with a less-apparent disability and qualifying for disability status, the demands placed upon disability support offices will continue to grow (Burke et al., 2010). For example, AT support offices will likely need to adjust service provision to best meet the unique needs students with less-apparent disabilities have in relation to learning and AT use. To this end, AT personnel must be armed with data to demonstrate AT accommodations and service results, as well as details about student characteristics that may affect said results. Finally, dropout from AT services is a particularly concerning outcome for students with less-apparent disabilities, yet it is not addressed in the research literature. Although a few quantitative and qualitative studies demonstrate how remaining in AT services benefits academic progression in college students (Malcolm & Roll, 2017b; Orlando, Klinepeter, & Foster, 2016), factors that may predict whether or not a student is at risk for dropping out from AT services have not been identified.

The purpose of this retrospective analysis of secondary data was to examine AT-service self-reported outcomes and the impact of personal characteristics on outcomes in a population of post-secondary students who had a less-apparent (but disclosed and documented) disability as identified by the campus Disability Support Office (DSO). We also sought to examine how personal characteristics related to baseline self-ratings of performance and satisfaction on academic tasks. These data are needed to strengthen our understanding of students' personal and

self-perceived status when they present for AT service. We specifically sought to answer the following research questions regarding post-secondary students with less-apparent disabilities:

1. Do their self-reported *Performance* and *Satisfaction* ratings on academic tasks improve following delivery of AT accommodations and services over an academic semester?
2. Are personal characteristics (gender, class-level, STEM major membership) significantly related to (a) COPM initial scores or (b) a service-meaningful change in COPM scores? Here we use the term "service-meaningful" versus "clinically meaningful" because the therapeutic context involves support services rather than clinical treatment.
3. May the level of a student's participation with AT services be predicted? (a) Using the student's personal characteristics, may we predict whether or not she/he will follow through with a referral to AT services from the DSO?, and (b) using personal characteristics and initial COPM scores, may we predict whether or not a student will prematurely dropout of AT services?

Method

Overview

This study is a retrospective analysis of de-identified client data generated over a 5-year period as part of regular and mandated assistive technology services at a western state university's Assistive Technology Resource Center (ATRC). The ATRC is housed within the academic Department of Occupational Therapy, and is staffed by professionals with backgrounds in occupational therapy and information technology. Students are referred to the ATRC by the disability support office (DSO) and are eligible for reasonable accommodations including the provision of AT or auxiliary aids. Clients studied received AT services and were evaluated using the Canadian Occupational Performance Measure (COPM) at the beginning (Time 1) and end

(Time 2) of an academic semester during which AT services were received. We also collected demographic data related to the student's gender, class-level (e.g., Freshman, Sophomore, etc.), STEM major membership, and primary diagnosis for which AT services were sought (Table 1). Due to confidentiality issues relating to our retrospective study design, we were unable to access objective academic data on our sample (e.g., grade point average, graduation, etc.).

As part of the ATRC's standard operating procedures, all clients were informed that demographic, COPM, and AT use data would be collected as part of the usual process for evaluating a student's needs and characteristics to identify appropriate AT supports and services, and to ascertain any changing needs and progress as AT services were delivered. All study procedures were approved by the local institutional review board.

Clients Studied

While the ATRC serves college students with any type of diagnosis or disability, this retrospective analysis focused on individuals with a less-apparent disability, i.e., the disability is not associated with a visually-obvious deficit. This criterion was implemented because the AT-needs and supports are typically quite different between students with less-apparent versus apparent disabilities, and AT outcomes for less-apparent diagnoses are less widely published or known. Additionally, less-apparent disabilities have become the largest population served in terms of type of disability served, so understanding the needs and performance of this group of students has become imperative (Kena et al., 2016). From 2011 to 2015, 231 students with less-apparent disabilities including learning disability, attention deficit disorders, and autism spectrum disorder were referred to the ATRC. These students were identified for inclusion strictly based upon the diagnosis assigned by the DSO. Table 1 displays the descriptive data on the demographic make-up of the sample, the number of students who followed through with a

referral to the ATRC, and the number of students who dropped out before completion of services.

AT Services

The ATRC is staffed by a team consisting of a director with substantial expertise in AT, two occupational therapists, an IT support person, several graduate occupational therapy student assistants, and a research director. At the time data were generated, students were referred to the ATRC by the DSO if the need for technology accommodations or improved access to technologies was evident. Such accommodations are also referred to in legislative mandates (e.g., Americans with Disabilities Act and Section 504 of the Rehabilitation Act) as the "provision of auxiliary aids". The ATRC then completed an intake assessment to determine what academic tasks were challenging in light of the student's disability. ATRC services then consisted of a structured trial-and-error process to determine potential technological accommodations followed by training for use and application on academic tasks. In this regard, assessment of needs was very student-centered and AT solutions were uniquely tailored to the student. For example, if information from the intake assessment suggested that a student struggled with reading and might benefit from literacy support technology, the ATRC staff would introduce a variety of literacy support technologies and attempt to identify the most appropriate alternate format for their individual needs (considering technology comfort, type of academic content, and technology platform). Students presenting to the ATRC often experience challenges in more than one academic task and may also have different needs based upon coursework, learning environments, and personal characteristics (e.g., amount of time in college). Therefore, multiple AT solutions may have been required for an individual student, and considerable variability existed between students in the AT solutions employed. Table 2

lists and describes commonly applied AT for these clients. AT to support one task (e.g., reading) may have also benefited performance and satisfaction on other academic tasks (e.g., test-taking).

Once the most effective assistive technology(ies) were identified, the ATRC worked with the student to identify the most logical location to provide AT. Perhaps dissimilar to other post-secondary education models that employ a segregated AT lab, the ATRC placed the technology in locations most efficient and useful for students. Accordingly, training was always contextual, occurring in the location(s) where students intended to use the technologies. These settings included student computer labs, campus library, other academic support offices, and installation on personal computers as licensing allowed. Once location(s) of use were decided, the ATRC provided thorough training and support in the application of AT and mainstream technologies to actual academic tasks. Training was provided in a variety of ways: students could practice with an ATRC staff member present as a resource, could have one-on-one demonstrations of applications and/or could refer to on-line multi-media tutorials. The ATRC also provided a library of loanable AT and mainstream technology devices and equipment, which student-clients could access on a semester-by-semester basis at a variety of on- and off-campus locations. The ATRC provided as much support as was required for the individual to reach a level of independence with her or his AT. Service providers in the ATRC catered training to the individual needs. Training focused on using the AT to complete academic tasks vs training on specific features of the technology. For example, a student with dyslexia and who used text-to-speech for reading would receive training in how to overlay the text to speech option onto course readings including textbooks, handouts, assignments, etc. When the student felt comfortable using the technology features to complete the academic task, they were deemed independent.

Students could seek additional assistance at any point in the semester, with no limit on the number of visits.

Measurement: The Canadian Occupational Performance Measure (COPM)

The COPM was the primary outcome measure and was administered by an Occupational Therapist (OT) overseeing student AT services. The COPM is a client-centered instrument that is commonly used by occupational therapists to identify self-reported problem-areas in occupational (a.k.a. "activity") performance and asks the client to evaluate her/his *Performance* and *Satisfaction* relative to those problem areas (Law et al., 2005). As an outcome measure, the COPM assesses changes in the client's perception of her/his *Performance* and *Satisfaction* over time. The evaluation is conducted as a semi-structured interview where a client first identifies activities she or he wants, needs, or is expected to perform, and rates the *Importance* of each activity from 1 (not important at all) to 10 (extremely important). Next, the client rates her/his *Performance* on each activity from 1 (not at all able) to 10 (able to perform extremely well). Finally, the client rates *Satisfaction* from 1 (not at all satisfied) to 10 (extremely satisfied). Because the ATRC staff wanted to focus on the most-common, educationally-related occupations post-secondary students with disabilities must perform, clients were asked to rate their *Performance* and *Satisfaction* on a modified version of the COPM with program-specific activities as the starting point for individualized outcome measures that are commonly relevant and necessary for college students: reading, writing (typing or handwriting assignments), note-taking, test-taking, and studying. For example, the interviewer would ask "how would you rate your performance of reading as a college student?" and then "how satisfied are you with your performance of reading?" A priori establishment of program-specific activities to be measured

with the COPM has been previously established as an acceptable method to focus on targeted and service-meaningful outcomes of therapeutic services (Di Rezze, Wright, Curran, Campbell, & Macarthur, 2008; Roberts, Derkach-Ferguson, Siever, & Rose, 2014). The COPM was administered by an occupational therapist with extensive training and experience in using the measure and who oversaw services related to students receiving AT accommodations. The COPM has been demonstrated to have moderately strong test-retest reliability (Eyssen, Beelen, Dedding, Cardol, & Dekker, 2005) and has been confirmed as having good divergent and construct validity (Dedding, Cardol, Eyssen, Dekker, & Beelen, 2004).

As part of usual accommodations and services for students with a disability, the OT who administered the COPM also typically delivered AT services to the student-client. Such integration of assessment and service provision is necessary to ensure that assessment and AT services and supports are well-integrated. Administration of the COPM occurred at the start (Time 1) and end (Time 2) of the semester in which AT services were delivered. Students were blinded to Time 1 COPM scores during assessment of Time 2 COPM scores.

Statistical Analysis

The primary outcomes were COPM *Performance* and *Satisfaction* ratings for academic tasks of reading, writing, note-taking, test-taking, and studying. Each research question and sub-question required separate analyses. To answer our first research question (RQ1), do self-reported *Performance* and *Satisfaction* ratings on all academic tasks improve following delivery of AT accommodations and services over an academic semester?, we analyzed differences in Time 1 and Time 2 COPM scores for each individual academic task with separate paired samples t-tests. Especially when the COPM tasks (e.g., reading, writing, etc.) are the same across clients (as in this study), examining changes in the individual task scores provides specific information

relative to a particular problem area (Law et al., 2005). In total, 12 paired sample t-tests were run (*Performance* on five academic tasks; *Satisfaction* on five academic tasks; and the overall average *Performance* and *Satisfaction* scores). The magnitude of effect sizes (Cohen's *d*) were considered small at 0.2, moderate at 0.5, and large at 0.8 (Cohen, 1988). To correct for multiple t-tests in RQ1, we adjusted alpha using the Bonferroni correction (α=.004; i.e., .05/12). For research question 2(a) (RQ2a), we employed two multiple linear regressions (one for each dependent variable) to examine the relationship between personal characteristics of gender (female=1, male=0), class level (1-5, corresponding to Freshman, Sophomore…Graduate Student), and STEM (1) or non-STEM (0) major on dependent variables of Time 1 COPM average *Performance* score and Time 1 COPM average *Satisfaction* score. An effect size for the regression model was calculated using Cohen's f^2 (Selya, Rose, Dierker, Hedeker, & Mermelstein, 2012). For RQ2b, we examined the relation of the predictor variables to the dependent variables in terms of service-meaningful change, and converted average *Performance* and *Satisfaction* change scores into binary variables, i.e., service-meaningful (1) or non-service-meaningful (0) change. The thresholds for service-meaningful changes in average COPM *Performance* and *Satisfaction* were based upon Eyssen et al.'s (2011) results from criterion responsiveness analyses of the COPM, which indicated that a 0.90-point change in *Performance* score and a 1.45-point change in *Satisfaction* score are appropriate cutoffs to determine whether or not the change in COPM scores are service-meaningful (Eyssen et al., 2011). To answer RQ2b, we therefore ran two separate binary logistic regressions with dependent variables of service-meaningful average *Performance* and *Satisfaction* change, and with the same predictor variables as in RQ2a. We set α=.05 for RQ2a and RQ2b. For research question 3(a) (RQ3a) we used logistic regression with personal characteristics as predictor variables and referral outcome

(show or no-show) as the binary dependent variable. For research question 3(b) we used logistic regression with personal characteristics and COPM initial scores as predictor variables and AT service completion (dropped out or not dropped out) as the binary dependent variable. We set α=.05 for RQ3a and RQ3b. For all regression analyses, we used forced entry to enter all predictor variables into the models simultaneously. We selected this entry method as it is preferred over the selection method of entry (e.g., stepwise regression) when a theoretical basis for order of entry is not apparent (Field, 2013). All statistical analyses were done using IBM SPSS Statistics for Windows, Version 24 (Armonk, NY: IBM Corp.).

Results

Research Question 1 Results: Change in COPM Scores

Response rates for the five occupation (academic task) areas of the COPM ranged from n=103 to n=105 (out of n=105). This range occurred because two students did not wish to rate *Performance* or *Satisfaction* in an area they deemed irrelevant (e.g., test-taking). When examining COPM *Performance* scores, we found that student ratings of their *Performance* on all of the common academic occupations of reading, writing, note-taking, test-taking, and studying significantly increased from Time 1 to Time 2 (Table 3), as did the average overall *Performance* rating (t_{104}=8.03; p<.001, d=-0.78). Effect sizes for changes in COPM *Performance* are also displayed in Table 3 and were large for reading; moderate for note-taking and test-taking; and small for writing and studying. We also found that *Satisfaction* ratings on all academic occupations significantly increased from Time 1 to Time 2 (Table 3), as did the average overall *Satisfaction* rating (t_{103}=9.49; p<.001, d=-0.93). Effect sizes for changes in COPM *Satisfaction* were large for reading; and moderate for writing, note-taking, test-taking, and studying.

Research Question 2 Results: Relationship of Personal Characteristics to COPM Scores

Regression results for RQ2a and RQ2b are presented in Table 4. For RQ2a, two separate multiple linear regressions were performed to predict whether or not Time 1 COPM *Performance* and *Satisfaction* were related to predictor variables gender, class, and STEM major. Complete COPM Time 1 scores were available for 186 of the 187 students. The regression model for Time 1 *Satisfaction* trended towards significance ($F_{3,183}$=2.54, p=.058, R^2 of .04, f^2=.042). Gender significantly predicted *Satisfaction* score at Time 1 (p=.01). Self-ratings by females were .63 points lower than male self-ratings. Given that the model was not significant, the predictive strength of gender is less robust, but may indicate an area for further exploration.

The regression model was not significant for Time 1 *Performance* scores. For RQ2b, two separate binary logistic regressions were performed to predict service-meaningful changes in average COPM *Performance* and *Satisfaction* ratings based upon predictor variables gender, class, and STEM major (or not). COPM change scores were available for 105 students. Descriptively, 70 students (66.7%) experienced a service-meaningful improvement in COPM *Performance*, and 35 (33.3%) did not. In contrast, only 37.5% of students experienced a service-meaningful improvement in COPM *Satisfaction*, leaving 62.5% who did not. The logistic regression model for *Performance* change (X_3^2=7.73, p=.05) explained 9.9% (Nagelkerke R^2) of the variance in whether or not the *Performance* change was service-meaningful and correctly classifying 67.6% of cases. Gender significantly predicted *Performance* change, with females being 2.79 times more likely than males to have a *Performance* change score that was service-meaningful (p=.02). The logistic regression model was not significant for *Satisfaction* change scores.

Research Question 3 Results: Do Personal Characteristics or Initial COPM Scores Predict Participation with AT Services?

Regression results for RQ3a and RQ3b are presented in Table 4. In the period of 2011-2015, 231 students with a less-apparent disability were referred to the ATRC, and 187 of these students presented to the ATRC following referral (44 did not). For RQ3a, a logistic regression was performed to determine the effects of gender, class, and STEM major (or not) on the likelihood that a student client would follow through with a referral to the ATRC (show or no-show). The logistic regression equation was significant (X_3^2=8.58, p=.04). The model explained 6% (Nagelkerke R^2) of the variance in whether or not a student would show-up to the ATRC following referral from the DSO and correctly classified 81.0% of cases. Increasing class-level

was associated with an increased likelihood of following through with a referral. As the year in school (class-level) increased by one unit, a student was 1.43 times more likely to show-up following referral (p=.006). Gender and STEM major status were not significantly predictive of referral outcome. For RQ3b, a logistic regression was performed to determine the effects of gender, class, STEM major (or not), and COPM task *Performance* and *Satisfaction* scores at Time 1 on the likelihood that a student would complete ATRC services delivered in a semester. Of 187 students who followed through with referral to the ATRC, 82 eventually dropped out and 105 did not. The logistic regression model was significant (X^2_{13}=40.36, p<.001). The model explained 26% (Nagelkerke R^2) of the variance in whether or not a student would drop out from AT services and correctly classified 72.6% of cases. Increasing class-level was associated with an increased likelihood of not dropping out from AT services. As the class-level increased by one unit, the student was 1.27 (p=.053) times more likely to not dropout of services. Students with higher initial ratings of reading *Performance* and *Satisfaction* and studying *Performance* and *Satisfaction* were more likely to continue with AT services. As ratings for Time 1 reading *Performance* and *Satisfaction* each increased by one unit, the student was 0.64 (p=.005) and 1.34 (p=.028) times more likely to not dropout from AT services, respectively. As ratings for Time 1 studying *Performance* and *Satisfaction* each increased by one unit, the student was 2.19 (p<.001) and 0.62 (p=.005) times more likely to not drop out, respectively.

Discussion

Do students with less-apparent disabilities self-report improved *Performance* and *Satisfaction* ratings on academic tasks following delivery of AT accommodations and services?

We employed the COPM to measure the self-perceived performance and satisfaction experienced by clients seen in our ATRC, as this assessment tool is one of the most widely-used individualized measures of client self-perception of problems encountered in occupational performance (Doig, Fleming, Kuipers, & Cornwell, 2010). We draw from the field of occupational therapy to define "occupational" as relating to the "doing of work, play, or activities of daily living within a temporal, physical, and sociocultural context that characterizes much of human life" (p.1) (Kielhofner, 2002). In our population of college students with a less-apparent disability, we focused on the 'doing of academic work' within the post-secondary education context of their lives. Specifically, we examined how they rated their occupational *Performance* and *Satisfaction* on academic tasks of reading, writing, note-taking, test-taking, and studying, all of which are arguably key actions a student must undertake to successfully meet the demands of the student role. On average, students tended to rate their *Performance* and *Satisfaction* on academic tasks in the moderate range prior to initiation of AT services. We found that students with less-apparent disabilities who participated with ATRC services demonstrated significant increases in their COPM *Performance* and *Satisfaction* ratings across academic tasks of reading, writing, note-taking, studying, and test-taking. *Performance* and *Satisfaction* ratings for all tasks and for the overall average ratings increased to a moderate-high level. This finding is in keeping with a previous investigation of students with any type of disability (i.e., apparent or less-apparent) or combination of disabilities, which revealed

significant increases in the students' COPM ratings of their ability to complete these same academic tasks (Malcolm & Roll, 2017b). We take this as an encouraging finding that clients are significantly improving, yet we acknowledge that statistically significant changes must be examined for "service meaningfulness" (a context-specific equivalent to "clinical meaningfulness").

Distinguishing between statistical and service meaningful change is important and common in therapeutic and rehabilitation research. In a study by Eyssen et al. (2011) results from criterion responsiveness analyses of the COPM indicated that a 0.90-point change in *Performance* score and a 1.45-point change in *Satisfaction* score are appropriate cutoffs to determine whether or not the change in COPM scores are service-meaningful (Eyssen et al., 2011). Overall, we found the overall average *Performance* rating (0.90) to equal the minimum improvement cutoff and the average *Satisfaction* rating (1.28) to be slightly smaller than the cutoff. In contrast, a previous study of students with any or multiple disability types found that both *Performance* and *Satisfaction* changes were approximately equal to the cutoffs Eyssen's group put forward (Malcolm & Roll, 2017b). So, while the findings presented in the current study suggest that students with less-apparent disabilities experienced significant increases in their COPM scores, the magnitude of the average *Satisfaction* service-meaningful change was slightly lower than the general population of students receiving AT supports and services. This finding likely relates to the fact that two-thirds of our sample did not experience a service-meaningful change in the average COPM *Satisfaction* score; an issue that relates to personal characteristics, as addressed in the next section. Regardless, a larger degree of change would have made the Time 1 to Time 2 gains more meaningful from a service-related standpoint.

Are personal characteristics significantly related to COPM initial scores or a service-meaningful change in COPM scores?

Given that research in higher education indicates that certain student characteristics may influence outcomes and academic success (Graunke & Woosley, 2005), we investigated how the personal characteristics of our students with less-apparent disabilities might influence baseline self-perceptions and whether or not a service-meaningful improvement in self-perceptions was achieved following AT services. Only gender was predictive of initial COPM *Satisfaction* and whether or not COPM *Performance* improved to a service-meaningful degree. More specifically, women's ratings were lower than men's at initial assessment of *Satisfaction*, but women were more likely than men to experience a service-meaningful change in *Performance* following AT services. These findings relate to previous work that suggests women are initially more conservative in self-appraisal than men are (D'Lima, Winsler, & Kitsantas, 2014; Lopez, 2014; MacPhee, Farro, & Canetto, 2013), but also that women tend to experience an advantage over men in terms of academic achievement (Buchmann & DiPrete, 2006; Dwyer, Hodson, & McCloud, 2013). However, research in post-secondary education students with disabilities or deficits (Dockrell, Bennett, & Culleton-Quinn, 2015) and without disabilities (Hu, Li, Li, & Huang, 2015; Van Seters, Ossevoort, Tramper, & Goedhart, 2012; Wentworth & Middleton, 2014) has revealed that gender typically did not play a role in objective learning outcomes, and particularly when learning activities involve technology use. A key difference between these contrasting views may involve whether or not subjective or objective measures were employed, the latter of which appears to be less influenced by gender. Nonetheless, we conclude that students with less-apparent disabilities may self-rate themselves differently according to gender, and that these appraisals change over time. Descriptively, our finding of a higher initial

Satisfaction rating for males may relate to their greater tendency to dropout (49% dropout rate) of AT services, as compared to females (40% dropout rate). Similarly, women may have an advantage in remaining motivated to not drop out (60% completed services) than males (50.1% completed) because they were perceiving greater benefits of AT services on *Performance* change than were males. Certainly, objective measures of academic performance would strengthen our understanding of gender-effects in relation to AT services.

We were surprised that membership (or not) in a STEM major did not relate to COPM scores. Previous research has shown that students with disabilities enrolled in STEM majors have more complex needs for accommodations than non-STEM majors (Moon et al., 2012). We have also noted in our own practice that less AT exists to increase access to scientific literature and notations inherent in STEM education as compared to a wealth of AT for non-STEM content. Two issues may underlie our findings of no apparent effect of STEM versus non-STEM major on AT service results. First, we used federal guidelines (U.S. Department of Homeland Security, 2016) to classify majors as STEM or non-STEM. The validity of federal, international, and institutional classifications is frequently criticized due to inconsistent standards, professional bias, political bias, and over- or under-inclusion of academic majors in the STEM category. As such, our classification scheme may have inadvertently assigned students to the incorrect STEM/non-STEM category. Second, independent of their academic major and as part of the post-secondary general education requirements, students are often required to enroll in STEM or non-STEM courses. We did not track whether a student was seeking or using AT for the purposes of STEM content. Thus, the possibility exists that students in STEM majors used and benefited from AT for non-STEM content.

Do Personal Characteristics or Initial COPM Scores Predict Participation with AT Services?

A student's ability to follow through with referral for AT services is especially important if the student has a less-apparent disability. Previous research has demonstrated that these individuals are often less likely to recognize a need for learning accommodations such as AT supports and services (Newman & Madaus, 2015), and experience challenges in self-determination to seek out assistance. This may especially be the case during early college years, which are typically more challenging for students with a disability (Shepler & Woosley, 2012; Wolf, 2001). In line with this previous work, we found that class-level significantly predicted whether or not a student would show up to the ATRC following referral. Students who were further in their college careers were more likely to show up, although class-level did not predict the results of AT services. Furthermore, our results demonstrate that early class-level students (e.g., Freshman, Sophomore) are at increased risk for dropping out from AT services. These findings suggest that students with less-apparent disabilities in the earlier years of college may require additional out-reach and counseling to attend AT services once a referral has been generated from the DSO, and to continue with AT services throughout the semester.

Our findings indicate that the student's initial reading and studying *Performance* and *Satisfaction* ratings predicted whether or not she/he would remain in AT services throughout the semester. Higher ratings for reading and studying were associated with a greater likelihood for remaining in services. Students who perceive less challenges in their reading and studying abilities may require less-involved AT services and accommodations, thereby allowing them to more easily integrate their AT service appointments into their academic schedule. Alternatively, these same students may be at a greater advantage for success with AT services due to a higher

level of ability at Time 1. In addition to the relationship between self-perceived status and continuation with AT services, further research is needed to objectively assess the impact of initial abilities on reducing the risk of dropout from AT services.

Future studies that address dropout from AT services should also examine technology abandonment. For example, students who dropped out from AT services in our study may have done so because they felt a particular assistive technology was no longer useful or necessary for their learning needs. While trial-and-error is a usual part of finding the correct AT fit with student needs, complete abandonment of AT supports and services may indicate that the technology or AT services are inadequately increasing access and success for learning activities. Alternatively, the possibility exists that students who drop out from AT services feel that they are able to independently use their AT and no longer need one-on-one support from an AT professional. We were unable to assess the reason for dropout, but future work must do so.

Limitations

The fidelity of our analyses of STEM vs. non STEM majors is limited due to the considerable variation that exists in classification of STEM majors. We relied upon the Department of Homeland Security's STEM designated degree program list to classify majors as STEM or non-STEM (U.S. Department of Homeland Security, 2016). However, other STEM taxonomies (e.g., National Science Foundation Classification of Instructional Programs) differently define STEM and therefore differ in the classification of STEM majors (Green, 2007). Additionally, regardless of whether a student is in a STEM or non-STEM major, she or he is often required to take STEM and non-STEM courses as part of undergraduate general education requirements. In this regard, future studies should consider the type of courses (i.e.,

STEM or non-STEM) for which students are using AT rather than major alone. Due to confidentiality issues relating to our retrospective study design, we were unable to access objective academic data on our sample (e.g., grade point average, graduation, etc.). Future prospective studies linking AT services to objective academic outcomes should plan accordingly to obtain necessary client consent and access to academic records. This is especially important because self-reported changes do not necessarily translate into objective changes in ability. For example, Schmitt and colleagues (2012) found that while students who used a reading pen self-reported that the AT was beneficial, objective reading comprehension did not improve (Schmitt et al., 2012). Subjective perceptions of the impact of AT services should, however, not be abandoned altogether. Research indicates that self-perceived academic success is also an important outcome of higher education (Boud, 2013). Rather, having both objective and subjective measures of academic performance and progress will be valuable in assessing the impact of AT services.

Administration of the COPM was done by an occupational therapist also involved in AT service delivery. Such integration of assessment and service provision is necessary to ensure that assessment and AT services and supports are well-integrated, and is common in service delivery models (Eagan, Dubouloz, Radmoski, & Latham, 2014). However, from a research methods standpoint, this approach presents the potential for bias in the event that the client elevated her/his scores with a desire to please the interviewer/therapist.

Students included in this investigation often required multiple AT solutions, which substantially and naturally varied from one student to another based upon the individual's needs, learning context, etc. For this reason, outcome data tied to a specific AT solution (e.g., modified display) was not available and would almost always be confounded by use of other necessary AT

solutions. Future research is needed to ascertain the benefits of *specific* AT solutions for post-secondary students with less-apparent disabilities.

Finally, we did not collect data on the contact hours each student had with the ATRC, which could have been useful in examining the effect that the amount of staff support had on subjective ratings. Recently, we have moved to begin collecting data on contact hours between the ATRC and its student-clients. Overall, we have found that the amount of contact substantially varies according to the student's needs, number of AT solutions required, and contextual learning factors (e.g., course of study, learning environments, etc.). For example, in a recent semester during which 87 students were served, training time varied from 5 minutes to 11 hours (mean, 3.12 ± 2.07 hours). We use a service-model that is consistent with therapeutic service provision in other educational environments (e.g., K-12 school system) and clinical environments (e.g., out-patient rehabilitation). As such, AT services are individualized and significantly vary from student to student according to accessibility need, level of support required, and the form and content of required learning activities (e.g., learning for an English Literature major versus Chemistry major). Substantial inter-student differences between the extent, duration, and type of AT services, while appropriate for practical service delivery in a diverse population, does not easily allow for standardization of services. From a research perspective, we must therefore consider that differences in the provision of services may also impact outcomes. For example, a student who participates with more one-on-one sessions with an AT service provider may experience a better outcome than one who has fewer one-on-one sessions. However, the reverse could also be true: a student who has fewer one-on-one sessions may have less severe needs and only require a few sessions to master the AT. Nonetheless, we acknowledge that evaluating how AT services are delivered (duration, frequency, type) is very

important to identifying important intervention parameters and may impact the outcomes of AT service delivery.

Conclusion

Understanding the specific needs of post-secondary students with less-apparent disabilities is critically important to the higher education assistive technology field, as more of these students are attending U.S. colleges and universities. Our findings demonstrate the value of providing assistive technologies to college students with less-apparent disabilities in terms of their subjective performance and satisfaction on common academic tasks. Importantly, gender, class-level, and initial perceptions of reading and studying performance and satisfaction relate to some aspects of a student's success and participation with AT services. The fact that men tended to experience less improvement than women in their average *Performance* rating implicates a need for further research to ascertain unique characteristics and needs with which male students present when seeking AT supports and services. Based upon our findings, students in the earlier college years are at an increased risk for not following through with a referral to AT services and are more likely to dropout from services. Disability support offices and AT service offices may therefore need to consider ways to provide greater outreach and support to ensure students enter and remain in AT services to receive the necessary accommodations. Finally, additional research is warranted to determine the impact of AT on academic outcomes such as retention, graduation, and grade point average.

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Table 1. Demographic Data of Studied Sample

	Referred (n)	No-show (n)	Dropped out (n)	Did not drop out (n)
Total	231	44	82	105
Diagnosis				
Learning disability	166	32	60	74
Autism Spectrum Disorder	14	2	7	5
Attention Deficit Disorders	24	0	7	17
Other cognitive/behavioral	27	10	8	9
Gender				
Females	130	24	42	64
Males	101	20	40	41
Class-level				
Unspecified	37	17	8	12
Freshman	67	10	34	23
Sophomore	39	4	13	22
Junior	40	6	14	20
Senior	38	7	11	20
Graduate	10	0	2	8
STEM Major				
Non-STEM	148	29	57	62
STEM	83	15	25	43

Table 2. Common Assistive Technology Used In Our Center

AT Accommodation Categories	Description
AT for note-taking	Smartpens that syncrhonize audio lecture recordings to written notes, digital recorders, software or mobile applications for note-taking
Audio readings	Provides audio-only format of a book or class reading, i.e., in MP3 format
Modified display	Changes to color, font, and masking through variety of software and applications; color overlays, open dyslexic font
Text & Audio readings	Reading format that combines text and audio, e.g., text-to-speech
AT for writing	Software and mobile applications that addresses spelling, grammar, dictation, language production, mind-mapping, proof-reading with audio feedback
Text recognition	Software and hardware that provides optical character recognition to convert certain non-text file formats (e.g., PDF) into a text format; allows for audio reading and interaction with content
AT/ for time management & organization	Software and apps that assist with executive functioning
Single word display	Software and mobile applications that display single words during reading

Table 3. COPM Change Scores and Paired Samples T-Test Results

		Time 1			Time 2			Change	statistics	
Domain	Variable	n	Mean	SD	n	Mean	SD	Change	*t*	*p*	*d*
	Reading	105	5.5	2.0	105	6.9	1.9	1.4	8.44	<.001	0.82
	Writing	105	6.7	1.9	105	7.3	1.5	0.6	3.93	<.001	0.38
	Note-taking	105	6.6	2.0	105	7.4	1.9	0.8	4.48	<.001	0.44
Performance	Test-taking	105	6.5	2.0	105	7.3	1.6	0.8	4.93	<.001	0.48
	Studying	105	6.7	1.9	105	7.4	1.6	0.6	3.92	<.001	0.38
	Overall	105	6.5	1.3	105	7.3	1.1	0.8	8.03	<.001	0.78
	Reading	104	4.8	2.4	104	6.8	2.1	2.0	8.41	<.001	0.83
	Writing	104	6.5	2.3	104	7.3	1.8	0.8	4.99	<.001	0.49
	Note-taking	104	6.3	2.4	104	7.5	1.9	1.2	5.82	<.001	0.57
Satisfaction	Test-taking	103	5.8	2.6	103	7.0	1.9	1.2	5.78	<.001	0.57
	Studying	104	6.0	2.3	104	7.0	1.9	1.1	5.18	<.001	0.51
	Overall	104	5.9	1.7	104	7.1	1.5	1.3	9.49	<.001	0.93

Table 4. Results for Research Questions 2 and 3.

Research Question 2a

Dependent Variable$_1$	Time 1 COPM Average *Performance*
Regression Result	$F_{3,183}$=.98, p=.40, R^2=.02, f^2=.042
Dependent Variable$_2$	Time 1 COPM Average *Satisfaction*
Regression Result	$F_{3,183}$=2.54, p=.058, R^2=.04

Coefficients

Predictor variable	*B*	*SE B*	β	*t*	*p*
Gender	-0.627	0.243	-0.188	-2.581	0.011
Class	0.083	0.085	0.072	0.986	0.325
STEM major (or not)	-0.19	0.255	-0.055	-0.759	0.449
Constant	5.854	0.263	-	22.26	<.001

Research Question 2b

Dependent Variable$_1$	Clinically meaningful (or not) change in average COPM *Performance*
Regression Result	χ^2(3)=7.73, p=.05, *Nagelkerke*=.99

Coefficients

Predictor variable	*B*	*SE B*	*Wald* X^2	*p*	*OR*	95% C.I.for *OR* Lower	95% C.I.for *OR* Upper
Gender	1.026	0.438	5.500	0.019	2.791	1.184	6.579
Class	-0.175	0.150	1.368	0.242	0.839	0.626	1.126
STEM major (or not)	-	0.43	1.20	0.27	0.62	0.26	1.45

	0.475	3	2	3	2	6	4
Constant	0.728	0.493	2.183	0.140	2.071	-	-

Dependent Variable[2]	Clinically meaningful (or not) change in average COPM *Satisfaction*
Regression Result	$\chi^2(3)=2.31$, $p=.51$, *Nagelkerke*=.03

Research Question 3a

Dependent Variable	Referral outcome (show or no-show)
Regression Result	$\chi^2(3)=8.58$, $p=.04$, *Nagelkerke*=.06

Coefficients

						95% C.I.for *EXP(B)*	
Predictor variable	*B*	*S.E.*	*Wald* X^2	*p*	*OR*	Lower	Upper
Gender	0.004	0.343	<.001	0.992	0.996	0.508	1.970
Class	0.359	0.130	7.666	0.006	1.432	1.111	1.846
STEM major (or not)	-0.047	0.363	0.017	0.896	0.950	0.470	1.940
Constant	0.819	0.330	6.053	0.014	2.270	-	-

Research Question 3b

Dependent Variable	Completion of services (no drop out or dropped out)
Regression Result	$\chi^2(13)=40.36$, $p<.001$, *Nagelkerke*=.26

Coefficients

						95% C.I.for EXP(B)	
Predictor variable	*B*	*S.E.*	*Wald* X^2	*p*	*OR*	Lower	Upper
Gender	0.59	0.35	2.803	0.094	1.80	0.90	3.59

Class	0.24	0.12	3.74 2	0.05 3	1.27	1.00	1.62
STEM major (or not)	0.51	0.35	2.06 1	0.15 1	1.66	0.83	3.30
Reading performance	-0.44	0.16	7.89 3	0.00 5	0.64	0.47	0.87
Writing performance	-0.04	0.16	0.06 2	0.80 3	0.96	0.70	1.31
Note-taking performance	-0.09	0.14	0.46 1	0.49 7	0.91	0.69	1.19
Test-taking performance	-0.16	0.17	0.92 7	0.33 6	0.85	0.61	1.18
Studying performance	0.79	0.21	14.6 17	<.00 1	2.19	1.47	3.28
Reading satisfaction	0.30	0.13	4.85 3	0.02 8	1.34	1.03	1.75
Writing satisfaction	0.11	0.13	0.63 7	0.42 5	1.11	0.86	1.44
Note-taking satisfaction	0.16	0.12	1.77 6	0.18 3	1.18	0.93	1.49
Test-taking satisfaction	0.10	0.14	0.53 1	0.46 6	1.11	0.84	1.47
Studying satisfaction	-0.48	0.17	7.72 2	0.00 5	0.62	0.44	0.87
Constant	-2.15	0.92	5.42 8	0.02	0.12	-	-