Measuring and Understanding Self-Handicapping in Education

by

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Abstract

Self-handicapping is intentionally fabricating obstacles to performance. It is very prevalent in education where it interferes with learning and lowers academic achievement. Few self-handicapping experiments have approximated authentic learning situations, elevating concerns about ecological validity and generalizability. This study addressed several methodological concerns by (a) posing a task common in education, and (b) offering participants multiple occasions to choose among several productive, neutral, or self-handicapping approaches to learning. Undergraduate learners were randomly assigned to receive contingent or non-contingent success feedback on three learning tasks. Each task offered multiple occasions to claim or practise self-handicapping by making selections within a component of the software. Those selections caused changes in the learning environment while participants worked on tasks and generated data about self-handicapping more realistically situated and in finer grain than data gathered in prior research. Results indicate this method for unobtrusively recording data about self-handicapping validly represented the construct. Learners' choices reflected preferences for certain handicaps and described patterns of hidden versus blatant self-handicapping. Evidence for self-handicapping and self-regulated learning across tasks was found. Some learners repeatedly self-handicapped, Others self-regulated learning over time by demonstrating metacognitive awareness, monitoring, and control of learning activities regardless of feedback provided. Encouraging metacognition may aid self-handicappers to more productively self-regulate their learning over time.

Keywords: behavioral self-handicapping; claimed self-handicapping; self-regulated learning; metacognition; trace data

To my family, who I can always count on.

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Chapter 1. Introduction

In the midst of enjoying a blithesome evening, one of his friends asked him about his premiere on the next day for which he had not yet finished preparing. It was about midnight when he withdrew to his room, sat down at his desk and began working. The next evening, a little before the curtain rose, hardly had the copyists finished transcribing the parts for the musicians, when Mozart entered the orchestra and took his seat at the piano (*Don Giovanni (Mozart) - Synopsis*, 2013).

Mozart had made a choice to spend the evening with his friends rather than composing the overture for Don Giovanni. In doing so, he appears to intentionally fabricated an obstacle to his performance, i.e., he self-handicapped (Berglas & Jones, 1978). Self-handicapping creates *a priori* excuses for prospective failure, particularly when failure entails a threat to self-esteem as might occur, for example, when a child prodigy composes a mediocre opera, an athlete loses in the playoffs, an employee causes economic harm, or a learner fails an important exam. There is consensus in the scholarly literature that behavioral self-handicapping – creating actual obstacles, such as reducing effort vs. merely claiming obstacles – is particularly detrimental (Leary & Shepperd, 1986).

Research indicates swimmers, wresters and professional golfers self-handicap by reporting decreased practice and poor nutrition before competitions (Bailis, 2001; Rhodewalt et al., 1984; Stone, 2002). Selecting these rather unobtrusive handicaps provides an excuse for prospective failure without attracting attention by teammates and coaches.

Research exploring self-handicapping in work contexts is sparse and focuses on employees' perceptions of individuals who self-handicap. Employees negatively judged self-handicappers described in vignettes. They disliked self-handicappers, would not want to socialize or collaborate with them, and assigned them unfavorable characteristics (e.g., incredibility, unintelligence, or incompetence; Hip-Fabek, 2005; McElroy & Crant, 2008; Park & Brown, 2014). Self-handicappers were judged particularly harshly when handicaps were behavioral, intrapersonal (e.g., refusing an opportunity for education) and practiced repeatedly. In contrast, claiming external

handicaps such as task difficulty appears to function as an impression management strategy as employees reacted with understanding (Hip-Fabek, 2005). Interestingly, while college students and employees were not willing to socialize or collaborate with adult workers who spent time with friends instead of preparing for an important presentation, they were lenient with college students using the same self-handicapping strategy (Park & Brown, 2014).

The vast bulk of research focuses on academic self-handicapping, particularly in post-secondary education, where it is very prevalent and has been linked to unfavorable motivation and academic achievement (Ommundsen et al., 2005; Schwinger et al., 2014; Zuckerman et al., 1998; Zuckerman & Tsai, 2005). A recent meta-analysis positioned self-handicapping as a global concern prevalent across learners' ages, ethnicities, school types and task domains (Schwinger et al., 2014). Despite considerable research on this widespread phenomenon, methodological issues challenge accurate assessments of self-handicapping in education.

The vast majority of self-handicapping research relies on self-report measures. However, self-handicapping is not operationalized consistently across these measures, jeopardizing the validity of amalgamating interpretations across studies (Schwinger et al., 2014). Berglas and Jones' (1978) pioneering study on behavioral self-handicapping set the stage for state of the art experiments in the field. After receiving success feedback on a solvable or an unsolvable task, learners were offered a chance to apply a self-handicapping strategy before proceeding with the next task. Performance on the first task was introduced as a reliable indicator for ability, entailing a self-esteem threat of prospective failure. Tasks in this paradigm were usually intelligence test items, such as anagrams or pattern completion; and learners' choices were mostly limited to either a binary choice (e.g., self-handicap or not) or trinary choice (e.g., performance conducive, inhibiting, or no strategy). Typically, only one self-handicapping strategy was offered. Handicaps were operationalized as adding a distraction (e.g., noise, music, lighting) or subtracting a favorable learning behavior, such as practice (e.g., Kim et al., 2010; Rhodewalt et al., 1991; Snyder et al., 2014). Although this research has advanced theory, neither the tasks nor the decision-making processes approximated realistic learning situations, thereby elevating concern for generalizability and ecological validity.

The present study addresses these issues by: (a) using a learning task common to post-secondary education, i.e., answering questions by searching the internet; and (b) providing multiple occasions to choose one or multiple self-handicapping, neutral, or productive ways of learning. This latter feature advances understanding about learners' choices of counterproductive versus productive approaches to learning. Behavioral self-handicapping is operationalized as making self-handicapping choices (e.g., listening to self-handicapping music) or refraining from selecting productive approaches to learning (e.g., highlighting text).

The present study aims to introduce a novel approach to measuring behavioral self-handicapping in education. The proposed behavioral measure offers learners choices that cause changes in the learning environment and generate data about self-handicapping as learners learn. Psychometric properties of the behavioral measure were analyzed to assess whether the measure adequately represents the construct of behavioral self-handicapping it intends to measure. Campbell and Fiske's (1959) multitrait multimethod approach was used to assess two categories of construct validity: convergent and discriminant validity. Convergent validity can be claimed when a strong correlation of theoretically highly correlated constructs is observed. In contrast, discriminant validity refers to observations of low correlations between constructs that theory describes as marginally correlated. To distinguish whether correlations of constructs are due to similarities of constructs or method of measurement, constructs were assessed with different measurement approaches: self-reports and unobtrusively traced behaviors. The academic self-handicapping scale, a self-report measure (ASHS: Midgley & Urdan, 1995; Urdan & Midgley, 2001) was examined as a criteria for convergent validity. Scores on the ASHS are hypothesized to strongly correlate with behavioral self-handicapping measured by the proposed behavioral measure.

Highlighting precision and the impostor syndrome were examined as criteria for discriminant validity. To assess highlighting precision, learners are instructed to highlight specific content of a text on the computer. Highlighting precision is operationalized as the percentage of a learners' highlights containing this content (Yue et al., 2015). Although self-handicapping is negatively correlated with cognitive strategy use (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007), there are no empirical indicators for a strong association between self-handicapping and highlighting precision. Because the proposed measure and highlighting precision are both behavioral measures gathering

trace data as learners learn, a weak correlation between these constructs is hypothesized.

Learners experiencing the impostor syndrome underestimate their abilities and thus feel like impostors (Clance & Imes, 1978). The impostor syndrome is measured through self-report and expected to correlate weekly to moderately with behavioral self-handicapping due to conceptual commonalities. Fear of failure is a central component of self-handicapping and the impostor syndrome (Clance, 1985; Thompson et al., 2000; Urdan & Midgley, 2001). Both constructs are associated with reduced self-efficacy, increased self-protection, and elevated self-presentational concerns (Berglas & Jones, 1978; Cockley et al., 2015; Craddock et al., 2011; Coudevylle et al., 2015; Gadbois & Sturgeon, 2011; Jöstl et al., 2012; Leary et al., 2000; Patzak, Kollmeyer, & Schober, 2017; Stewart & De George-Walker, 2014). Learners experiencing the impostor syndrome procrastinate on important tasks to momentarily delay negative emotions (Clance, 1985). Self-reported self-handicapping moderately positively correlated with the impostor syndrome (Cowman & Ferrari, 2002; Want & Kleitman, 2006). Ferrari and Thompson (2006) found learners scoring high on a measure of the impostor syndrome claimed more handicaps after receiving non-contingent failure feedback than learners reporting low impostor feelings. However, these learners did not differ in their choice to withdraw practice as a means to behaviorally self-handicap. It is unclear if this finding can be replicated when other choices to self-handicap are offered.

Chapter 2. Review of the Literature

2.1. Self-handicapping – An Overview

Tackling learning tasks is an everyday challenge for undergraduate learners. These tasks require constant decision making about investing resources (e.g., time and effort) and applying learning strategies. Theory describes these decisions as based on a mix of outcome and efficacy expectations, and a cost-benefit analysis. Importantly, success versus failure expectancies trigger different motivations and behaviors (Covington & Omelich, 1979; Eccles & Wigfield, 2002; Finn, 2015). In contrast to success forecasts, expectations of failure are associated with strategies that disadvantage learning and undermine achievement motivation, particularly strategies that reduce engagement or are selected to mitigate fear of failure, such as self-handicapping (Bandura et al., 1999; Chen et al., 2009).

Self-handicappers intentionally fabricate obstacles to hinder their performance (Berglas & Jones, 1978). Handicaps are actions taken or withdrawn prior to or during performance to create *a priori* excuses for prospective failure. They can be behavioral (e.g., reducing effort, withdrawing practice or listening to distracting music) or merely claimed factors beyond one's control (e.g., claimed test anxiety, fatigue, or illness). This affords external attribution of failure outcomes (i.e., to the handicap) and internal success attribution (i.e., to ability) utilizing Kelley's (1972) discounting principle of attribution. Blaming the handicap for failure to discount ability as a causal attribution minimizes responsibility for failure. For example, learners emphasized their ability had little bearing on poor intelligence test scores when they chose to listen to distracting music while answering the test items (Rhodewalt et al., 1991). Self-handicappers prefer modifiable labels such as lazy or procrastinator (i.e., the handicap) compared to jeopardizing the validity of more central characteristics of the self, such as being competent or worthy (McCrea & Hirt, 2011; Rhodewalt & Tragakis, 2014). Although self-handicapping is theorized to afford ability augmentation after successful performance (i.e., succeeding despite the handicap), there is limited empirical support for this assumption. Research indicates that mainly self-handicappers with high self-esteem augment ability attributions (e.g., Baumeister et al., 1989; Feick & Rhodewalt, 1997;

Rhodewalt et al., 1991; Tice, 1991). Overall, self-handicappers appear to be inclined to make attributions to external and unstable factors (Rhodewalt, 1990).

Self-handicapping is an integrative construct that involves cognitive, metacognitive and motivational processes including decision making, intrapersonal evaluation and attribution. A learner consciously makes cost-benefit-analyses when deciding to self-handicap. For example, a learner might doubt their ability to master a task at hand (i.e., self-efficacy), assume a lack of skills needed to successfully complete the task (i.e., judgement of knowledge), and make a choice to self-handicap (i.e., metacognitive awareness of strategy selection and its consequences). Self-handicappers are expecting to fail while hoping to succeed. Research indicates learners self-handicap in tasks where failure suggests a lack of ability and thus constitute a threat to self-esteem. The need to protect self-esteem, which is theorized as the driving force to self-handicap, is induced or increased by providing non-contingent success feedback. This feedback implies an obligation to maintain high performance while eliciting uncertainty regarding how success came about and how it can be repeated in a similar task (Alter & Forgas, 2007; Berglas & Jones, 1978; Kim et al., 2010; Thompson, 2004).

The need to protect the self appears to be intensified for learners with an entity rather than an incremental view about their intelligence (Ommundsen et al., 2005; Rickert et al., 2014; Snyder et al., 2014). Learners who believe their intelligence is fixed and cannot be changed either have to accept implications of failure or draw on alternative ways to protect the self. This is in line with research indicating that learners who view their intelligence as fixed are more likely to self-handicap or procrastinate and less likely to keep up with school demands than those with incremental views (Rickert et al., 2014). Snyder and colleagues (2014) provided undergraduates with either entity or incremental messages about giftedness. In contrast to learners receiving incremental messages, those with entity messages took advantage of available handicaps by claiming handicaps or dimming the light to work in darkness rendering successful performance less likely.

This self-protection perspective has been challenged by large volumes of research demonstrating self-handicappers' motives to manage others' impressions. This line of research emphasizes self-presentational benefits of self-handicapping in public. When the experimenter was aware of performance outcomes (i.e., non-contingent

success feedback) and witness to learners choices between drugs described as performance inhibiting, neutral, or performance enhancing, learners were more likely to select a drug they believed to hinder performance on an intellectual task (Berglas & Jones, 1978). Coudevylle and colleagues (2015) added an additional layer of social demand using normative comparison. They told learners that scores would be ranked to identify the best and worst student. In this case, learners claimed five times more handicaps than peers who believed their scores were confidential and made choices about handicaps in private. Coudevylle and colleagues' finding was replicated for male learners who were placed in front of a camera to observe their performance on a test of intelligence and their decision to reduce practice effort (i.e., handicap). In this setting, men identified more potential self-handicapping strategies than peers who completed the task and practiced without being observed (McCrea & Flamm, 2012).

Self-handicapping appears to have greater motivational impact when practiced in public then in private. Berglas and Jones (1978) demonstrated that male self-handicappers attributed success more frequently to ability in public than in private situations. Male self-handicappers also judged solvable and insolvable tasks as similarly difficult, which is theorized to diminish unfavorable attributions (i.e., success was due to the easy task rather than ability). Learners selecting performance debilitating drugs in public indicated they were more relaxed (Kolditz & Arkin, 1982), were more involved with the task, and appeared less affected by negative feedback (Deppe & Harackiewicz, 1996). Deppe and Harackiewicz (1996) speculated that self-handicapping may be a way to cope with negative evaluation and maintain intrinsic motivation toward the activity that is being evaluated.

Hobden and Pliner (1995) recommended abandoning the debate of self-protectionist versus self-preservationist motives and instead examined individual differences and situational components to explain when these motives affect behavior. They examined how perfectionism contributes to enhancing understanding about underlying motives of self-handicapping in public and private situations. To create public experimental conditions, experimenters asked learners to disclose personally identifiable information (e.g., name, student ID number, etc.) on questionnaires, scored performance, provided feedback, and were present when learners made self-handicapping choices. Learners who reported high levels of socially prescribed perfectionism handicapped more frequently in response to non-contingent success

feedback in public rather than private. This effect was not found for learners indicating low levels of socially prescribed perfectionism. This provides evidence for self-presentational motives of learners who strive to fulfill high standards of others, particularly when others are present. This is in line with research indicating elevated chances for self-handicapping by learners who are self-conscious in public and experience social anxiety (Gibson & Sachau, 2000; Shepperd & Arkin, 1989b; Strube, 1986). Tice (1991) focused on different levels of self-esteem and observed that learners reporting high levels of self-esteem strove to enhance their image in public, while those with low or moderate levels of self-esteem aimed for self-protection.

Gender has been identified as a robust individual difference in self-handicapping. Across studies, men have demonstrated a greater tendency to practice behavioral self-handicapping than women. Women judge self-handicapping by others more harshly than men even though claimed self-handicapping appears to be practiced equally by men and women (Hirt & McCrea, 2009; Török et al., 2018; Urdan & Midgley, 2001). A possible explanation that has received empirical support focuses on gender differences in beliefs about effort. Hirt, McCrea, and colleagues demonstrated that women place greater value on effort and are less accepting of effort withdrawal then men, mirroring gender differences in behavioral self-handicapping. This reduces women's practice of behavioral self-handicapping, for example, reducing effort. Beliefs about effort mediate gender and behavioral self-handicapping (self-reported and practiced), and evaluations of others who practice behavioral self-handicapping (Hirt et al., 2003; McCrea, Hirt, Hendrix, et al., 2008; McCrea, Hirt, & Milner, 2008). This approach enhances understanding about behavioral self-handicapping, particularly reducing effort, withholding practice, inadequate sleep, drinking, and listening to distracting music (Flamm, 2006; Kretschmann, 2008). However, the discrepancy between genders in behavioral and claimed self-handicapping has yet to be explained.

Yu and McLellan (2019) emphasized the role of achievement goals in explaining gender differences in self-handicapping. Boys who aim to avoid appearing socially or academically inadequate were more likely to practice self-handicapping than girls with the same aims, regardless of school subject (i.e., English and Math). This is in line with consistent findings indicating that learners who forecast failure in a task at hand and who adopt performance-avoidance goals (i.e., hiding a lack of competence) tend to practice self-handicapping (del Mar Ferradas et al., 2017; Elliot et al., 2006; Leondari & Gonida,

2007; Midgley & Urdan, 2001; Yu & McLellan, 2019). In contrast, aiming to develop academic competence (i.e., mastery goals) was negatively correlated with self-handicapping and has been discussed as a means to reduce academic self-handicapping (Z. Chen et al., 2018; del Mar Ferradas et al., 2017; Leondari & Gonida, 2007; Schwinger & Stiensmeier-Pelster, 2011; Török et al., 2018). Findings about the relationship between self-handicapping performance approach goals (i.e., aiming to demonstrate academic competence to others) are mixed. Some researchers found empirical support for a weak, positive correlation (del Mar Ferradas et al., 2017; Leondari & Gonida, 2007) while others observed a negative relationship (Urdan, 2004).

Self-handicapping allows learners to mask failure and disguise a lack of ability. This is particularly needed in contexts that place great emphasis on performance and achievement. Situations that prompt decisions to self-handicap include: a public component (i.e., performance is monitored by others), competition, beliefs that good performance is important to the individual, and failure taken to indicate threat. This makes achievement settings such as classrooms a fertile setting for decisions to self-handicap (Covington, 2000; Leondari & Gonida, 2007).

In education, self-handicapping is prevalent across school levels (i.e., elementary school to post-secondary education), ages, and ethnicities (Schwinger et al., 2014). While there are contradicting theoretical and empirical findings on the age at which learners begin to self-handicap, extensive evidence indicates it is frequently practiced in secondary and post-secondary education (Schwinger et al., 2014; Török et al., 2018). The vast bulk of scientific attention in self-handicapping research focuses on post-secondary education, particularly sampling undergraduate learners. Self-handicapping is a concern in post-secondary education as it undermines motivation, academic achievement and is associated with decreased well-being of learners (Ommundsen et al., 2005; Schwinger et al., 2014; Zuckerman et al., 1998; Zuckerman & Tsai, 2005).

2.2. Self-handicapping in Education

In education, strong empirical evidence indicates negative relationships between self-handicapping and valued outcomes for learners, teachers and educational institutions. In particular, self-handicapping has been related to learners' academic achievement, learning processes, motivation, and emotions.

Meta-analytic research found moderate negative correlations between self-handicapping and academic achievement (Schwinger et al., 2014). This relationship was found from elementary school to post-secondary education but was particularly strong for elementary and middle school learners. This variation might be due to differences in teachers' perceptions and grading practices in primary school as opposed to secondary and post-secondary education.

Longitudinal research found evidence for a downward spiral of decreasing academic achievement among self-handicappers. Across two subsequent academic years, high school learners with a strong tendency to self-handicap reported decreased English grades (Urdan, 2004). Zuckerman and colleagues (1998) demonstrated lower grade point averages of undergraduate learners who reported self-handicapping over the course of a semester, particularly when SAT scores were statistically controlled. This effect was mediated by unfavorable study habits among self-handicappers. They used less efficient study strategies and spent less time preparing for exams than learners who scored low on measures of self-handicapping. Perhaps learners selected these approaches to studying as a means to self-handicap.

This finding aligns with research indicating self-handicappers use less productive learning strategies. They report using surface learning strategies (e.g., rote processing) rather than deep learning strategies (e.g., critical thinking), cognitive strategies (e.g., elaboration), or self-regulation strategies (e.g., metacognitive monitoring and control; Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007). Self-handicapping has been reported to negatively correlate with concentration which might further contribute to a downward spiral of decreasing academic achievement (Ommundsen et al., 2005).

Even though tendencies to self-handicap are negatively correlated with using metacognitive learning strategies (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007), self-handicappers demonstrate metacognitive awareness about their ability in relation to task requirements and their decision making. Given that learners practice self-handicapping to avoid expected failure (Urdan & Midgley, 2001), theoretically they are aware about the mismatch between their skills and skills needed to master a task. This mismatch is reflected in self-handicappers' low self-efficacy (Gadbois & Sturgeon, 2011; Stewart & De George-Walker, 2014).

It is theorized that self-handicappers make cost-benefit analyses, taking into account possible implications of failure and attributional benefits of self-handicapping when selecting a strategy. Self-handicapping has been described as a strategic approach to avoid failure and its implications (Berglas & Jones, 1978, Urdan & Midgley, 2001). Handicaps provide an attributional “out” in case of failure. Much research demonstrates self-handicappers attribute failure externally, i.e., to the handicap (Greenberg, 1985; Hobden, 1999; Mayerson & Rhodewalt, 1988; McCrea, Hirt, Hendrix, et al., 2008; Rhodewalt & Hill, 1995). In Martin and colleagues’ (2003) interview about academic self-handicapping an undergraduate learner explained how she considered attributional benefits of self-handicapping when selecting a strategy: “If I leave it [study] to the last minute, then I've got an excuse if I didn't do well. Any excuse is better than ‘You're just not smart enough to do it.' I know that I should be putting effort in all the time, but then I've got the excuse if I don't go well.“ (p. 5). This learner describes a conscious decision to put off studying to create an excuse for prospective failure. This allows her to attribute failure externally (i.e., to the lack of time available for studying) and not internally (i.e., to ability). This suggests self-handicappers may be metacognitively monitoring their strategy selection.

Research demonstrates learners prefer less costly ways of self-handicapping, indicating their engagement in cost-benefit analyses. Rhodewalt and colleagues (1984) examined self-handicapping behaviors of professional athletes before important competitions. Athletes who scored low on a measure of self-handicapping increased their practice prior to important competitions. In contrast, athletes scoring high on the measure of self-handicapping impaired their performance in the upcoming competition by maintaining rather than increasing their regular practice. Even though reducing practice effort would be a more credible handicap, these athletes chose to self-handicap more inconspicuously without precluding their chance for success. A similar pattern emerged when offering learners a choice to claim or practise self-handicapping. Learners chose to claim handicaps, the less credible and costly way of self-handicapping more often than practicing behavioral self-handicapping (Hirt et al., 1991). These findings suggest self-handicappers are metacognitively aware of relative costs of different strategies when making self-handicapping choices.

Self-handicappers may be self-regulated learners with a tendency to select counterproductive rather than productive ways of learning. According to Winne and

Hadwin's (1998) model of self-regulated learning, learners move through a cycle of phases to regulate their learning. In the first phase, self-handicappers make inferences about the task at hand, compare their own skills against skills needed to master the task, and conclude that there is little prospect of success. Then, in phase two, they set a goal to avoid failure. In phase three, self-handicappers select a strategy they judge is most likely to help them achieve their goal and thus create or claim a handicap to performance. In phase four, learners evaluate their strategy selection, adapt or change the strategy for future tasks as needed (i.e., metacognitive control). However, there is little evidence that self-handicappers metacognitively control their learning. Longitudinal research suggests learners continue to make self-handicapping choices as opposed to self-regulating their learning by selecting more productive ways of learning (Zuckerman et al., 1998; Zuckerman & Tsai, 2005). Even when learners report intentions to get a head start on studying and put in more effort, they seem challenged to put these intentions into action. For example, a learner describing self-handicapping indicates that "…each time an exam or assignment approached I seem to do the same no matter how hard I try" (p. 4; Martin et al., 2003). This quote indicates a lack of metacognitive control. However, much has yet to be learned about metacognitive processes of self-handicappers.

Information processing – operationalized as the use of strategies to elaborate on or organize information – correlates positively with self-handicapping (Ommundsen et al., 2005). Even though the survey instrument used to measure information processing limits inferences about frequency, number, and awareness of strategies used, this finding seems paradoxical given the tendency of self-handicappers to select surface level learning strategies (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007). This effect could be explained by short-term motivational and emotional benefits of self-handicapping that allow learners to maintain task involvement in the face of failure, thus enabling them to continue information processing. Deppe and Harackiewicz (1996) demonstrated that learners who self-handicapped maintained intrinsic motivation towards playing pinball after receiving negative feedback while learners who did not self-handicap reported to be less involved in this task. Alter and Forgas (2007) drew similar conclusions. They examined how positive and negative mood influences learners' choices to self-handicap. Happy learners chose to drink performance-inhibiting herbal tea more often than learners in a sad or neutral mood. It is theorized that learners self-

handicap to maintain the good mood (Drexler et al., 1995). These short-term benefits of self-handicapping come with the cost of decreasing motivation and positive affect in the long run. Zuckerman and Tsai (2005) found evidence for a decline of intrinsic motivation and an increase of negative mood among undergraduate learners reporting use of self-handicapping strategies over time. This is in line with research indicating negative relationships between self-handicapping and motivation (Ommundsen et al., 2005), intrinsic value (Gadbois & Sturgeon, 2011), and student engagement (De Castella et al., 2013).

Beliefs about ones' ability to achieve academic goals have been demonstrated to be associated consistently with self-handicapping. Self-handicappers report low levels of self-efficacy (Gadbois & Sturgeon, 2011; Stewart & De George-Walker, 2014), self-concept (Ommundsen et al., 2005) and self-concept clarity (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007) across studies and academic domains. This indicates self-handicappers are uncertain about their ability to successfully complete academic tasks, which may intensify fear of failure and reinforce the selection of counterproductive ways of learning.

Fear of failure has been discussed as one of the primary motivations for self-handicapping (Urdan & Midgley, 2001). This assumption is in line with research demonstrating consistently moderate to strong positive correlations between self-handicapping and fear of failure (De Castella et al., 2013; Elliot & Church, 2003). However, self-handicappers also experience test anxiety (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007), anxious affect (Eyink et al., 2017), helplessness (De Castella et al., 2013), and defensive pessimism (De Castella et al., 2013; Martin et al., 2003). These relationships are indicators for unfavorable learning and undermine academic achievement. Zuckerman and Tsai (2005) observed long term negative effects of self-handicapping. Self-handicappers used unfavorable coping strategies (e.g., substance use) to deal with stressful situations. This, however, reinforces self-handicapping as stress is only reduced momentarily with the cost of defeating chances for achieving academic goals and gradually decreasing motivation and positive emotions over time. Self-handicapping has been robustly linked to constructs undermining productive learning.

The vast majority of research examining how self-handicapping relates to learning, however, is based exclusively on self-report measures of self-handicapping, raising uncertainty about the relation to actually practiced behavioral self-handicapping and how claimed versus behavioral self-handicapping impacs academic achievement. Theoretically, claimed and behavioral self-handicapping affect academic achievement differently. While behavioral self-handicapping provides less ambiguous excuses for prospective failure, it is also more detrimental as it decreases the likelihood of success. Even though claimed self-handicapping does not necessarily hinder chances for success, it is associated with negative consequences due to unfavorable motives driving decisions to self-handicap and harm to the image of self-handicappers (Hirt et al., 1991; Leary & Shepperd, 1986; Zuckerman & Tsai, 2005). Much has yet to be learned about how self-handicapping relates to learning in actual learning situations, highlighting a need for experimental investigation of behavioral and claimed self-handicapping in education.

2.3. Measuring Self-handicapping

Due to conceptual differences, claimed and behavioral self-handicapping are measured separately. Since claimed self-handicapping cannot be observed and can only be revealed by the handicapper, it is exclusively measured through self-report. To allow participants to use a claimed handicap as an *a priori* excuse for failure, participants are provided with an opportunity to claim one or multiple handicaps prior to being evaluated on a task. These measures, however, vary in the amount of guidance provided and number of choices offered to participants. Some experimenters bring participants' attention to available handicaps and investigate the uptake of those handicaps, thereby restricting and possibly priming participants' choices. For example, Smith and colleagues (1982) told participants that test anxiety inhibits performance on a task at hand and observed that participants claimed greater test anxiety when it was offered as a reasonable excuse for poor performance on the task. Other researchers presented a list of handicaps that could be claimed (e.g., headache, general test anxiety, or feeling tired). Participants are asked to rate how likely each handicap could negatively influence their performance on an upcoming task (Strube, 1986; Thompson & Richardson, 2001). The majority of these lists also provide the option to add and rate one or multiple other factors. Additional opportunity to claim handicaps is provided in studies using interviews

to collect data. Instead of providing potential handicaps to claim, participants are asked open-ended questions about factors that might influence their performance on the upcoming task. This approach, however, has primarily been used in sports rather than education (e.g., Carron et al., 1994). For example, Coudevylle and colleagues (2015) conducted interviews and asked physical education learners to identify reasons that could potentially explain outcomes in an aerobic task and rate how harmful or helpful they expect them to be. Similarly, Coudevylle and colleagues (2020) invited physical education learners to "list any event during the past week that might have been disruptive to the three exercises of this experiment" on a poster (p. 10). In contrast to prior research on claimed self-handicapping, the poster was visible to all learners, potentially adding social demand.

Behavioral self-handicapping has been primarily measured by questionnaires or in experimental research. Almost all studies relied exclusively on self-report measures, particularly the self-handicapping scale (SHS; Jones & Rhodewalt, 1982) and the academic self-handicapping scale (ASHS: (Midgley & Urdan, 1995; Urdan & Midgley, 2001).

The self-handicapping scale is the most frequently used measure for self-handicapping and has been used in its original form of 25 items and short form with 10 items (Strube, 1986) and 14 items (Rhodewalt, 1990; Zuckerman et al., 1998). Low internal consistency reliability was reported for all versions of the SHS; coefficients ranged from .62 to .78 (original SHS; Rhodewalt et al., 1984; Strube, 1986), and .67 to .72 (short forms; Strube, 1986; Warner & Moore, 2004; Zuckerman et al., 1998).

Items emphasize the use of self-handicapping behaviors. For example, reducing effort (sample item: "I would do a lot better if I tried harder") or procrastinating (sample item: "I tend to put things off until the last minute"). However, some items do not reflect operationalizations of self-handicapping. These items emphasize vulnerability to illnesses (sample item: "I suppose I feel under the weather more often than most people"), general eating and drinking behavior (sample item: "I overindulge in food and drink more often than I should"), concentration (sample item: "I am easily distracted by noises or my own day dreaming when I try to read") or excuse making (sample item "I tend to make excuses when I do something wrong"). Even though some of these behaviors could be used to self-handicap performance, these items do not include

central aspects of self-handicapping. For example, self-handicappers create *a priori* excuses, while excuse making occurs after receiving feedback. Additionally, items of the self-handicapping scale focus on general tendencies to engage in self-handicapping behaviors instead of emphasizing the motivation to do so. It is thus unclear whether learners scoring high on the SHS tend to self-handicap to create an excuse for prospective failure or for reasons unrelated to the construct of self-handicapping. This raises considerable concern about the validity of interpretations based on the SHS.

Urdan and Midgley (2001) acknowledged these methodological issues and proposed criteria for items aiming to assess self-handicapping. In line with operational definitions of self-handicapping, an item should include a self-handicapping behavior, a priori timing of the behavior, and a reason for engaging in it. The majority of the SHS items specify a self-handicapping behavior but fall short of indicating an *a priori* timing or providing a possible motivation to engage in this behavior. Some items even fail to identify a self-handicapping behavior. This is particularly true for items emphasizing illnesses (e.g., “Sometimes I get so depressed that even easy tasks become difficult”). While psychological and physical well-being can be claimed as handicaps, it is questionable to what extent these can be controlled. For example, learners can claim to suffer from depression which may have a negative effect on their performance, but how would learners fabricate depression? This raises questions about the type of self-handicapping addressed in this questionnaire: behavioral, claimed or a mixture of both? Despite these methodological issues, the SHS appears to maintain its popularity in the research community.

Midgley and colleagues (1995; 1996) developed the academic self-handicapping scale in line with their criteria for items assessing self-handicapping. The questionnaire comprises six items indicating self-handicapping behaviors such as procrastinating, reducing effort, or fabricating reasons that keep self-handicappers from studying or tackling learning tasks (e.g., friends, other activities, obligations, or reduced well-being). A sample item is: “Some students fool around (self-handicapping behavior) the night before a test (*a priori* timing) so that if they don’t do well, they can say that is the reason (motivation for the self-handicapping behavior). How true is this of you?”. Other items emphasize the intention of self-handicappers to fabricate obstacles more explicitly (e.g., “Some students purposely don’t try hard in school so that if they don’t do well, they can say it is because they didn’t try. How true is this of you?”). Internal consistency reliability

is reported to range from .79 to .84 (Gadbois & Sturgeon, 2011; Leondari & Gonida, 2007; Midgley et al., 1996; Thomas & Gadbois, 2007). The ASHS has been used solely or embedded in the patterns of adaptive learning survey (PALS; (C. Midgley et al., 1996; Midgley et al., 1996). The PALS is divided into a student and teacher scale. Besides academic self-handicapping strategies, the student scale also measures goal orientation, classroom goal structure, and perceptions and beliefs about academia, parents and home life.

Current meta-analytic research demonstrates that the choice between SHS and ASHS moderates how self-handicapping relates to other constructs. Schwinger and colleagues (2014) found evidence that differences between these questionnaires partially accounts for the variability of correlations between self-handicapping and academic achievement. Academic achievement was more strongly correlated with self-handicapping measured by the ASHS (r = -.23) than the SHS (r = -.11). Differences between these questionnaires' operationalization of self-handicapping, jeopardize the validity of interpretations across studies.

Research suggests that measuring self-handicapping "in action" (i.e., using experimental designs) rather than through self-report may be more methodologically rigorous. Self-report measures are not capable of clearly distinguishing behavioral and claimed self-handicapping which raises concerns about validity of interpretations based on these measures (e.g., Schwinger et al., 2014; Winne, 2020a). Additionally, researchers assuming the involvement of self-deception in self-handicapping choices emphasize concerns about the reliability of self-reported self-handicapping (Baumeister, 1996; Clarke & MacCann, 2016; McCrea, Hirt, Hendrix, et al., 2008; Rhodewalt & Vohs, 2005).

Experimental research has been inspired by Berglas and Jones' (1978) pioneering study on behavioral self-handicapping. This study set the stage for state of the art experiments in the field. After receiving success feedback on an unsolvable task, learners were offered a choice to take a drug presented as facilitating or debilitating performance (i.e., handicap) before proceeding with a similar task. Task performance was introduced as reliable indicator for ability, entailing a self-esteem threat of prospective failure. Experimental research on behavioral self-handicapping has drawn on this approach and established a consistent pattern for experimentally investigating

behavioral self-handicapping. In this paradigm, (a) failure on the task participants engage in is a threat to self-esteem, (b) uncertainty about the ability to succeed in a similar task is created, and (c) choices are offered to apply a self-handicapping strategy and/or alternative strategies. Uncertainty is created for the experimental group but not the comparison group. This also removes self-esteem threats as participants in the comparison group are confident in their ability to succeed in the next task. These groups allow for comparisons between participants who are likely to make self-handicapping choices and those who are likely to engage in alternative behaviors instead (e.g., selecting a drug presented as facilitating performance).

In this paradigm, tasks are selected and introduced in a way that failing the task would indicate a threat to participants' self-esteem (Shepperd & Arkin, 1989a; Thompson & Dinnel, 2007). Most of the experiments used intelligence or aptitude test items (i.e., verbal, spatial. mathematical ability). Scoring low on an intelligence or aptitude item indicates low ability, which is theorized to be a threat to self-esteem. Among the most frequently used tasks in self-handicapping research are non-verbal intelligence tests (e.g., the culture fair intelligence test; Cattell, 1961), analogy questions, (e.g., Miller, 1960), and matrices (e.g., progressive matrices; Raven, 1956). Perhaps these kinds of tasks were selected to lower transparency about how actions taken to complete the task translate to outcomes. This may increase the credibility of non-contingent feedback.

To increase the threat of prospective failure on tasks, experimenters introduced them as diagnostic of intelligence and predictive of academic and career success (McCrea & Flamm, 2012; Newman & Wadas, 1997; Thürmer et al., 2013). Learners were debriefed upon completion of the experiment. Tice (1991) for example, led participants to believe that the non-verbal intelligence test is a better predictor for post-academic success than traditional tests of intelligence. Other authors provided more detailed information to bolster their claim. Greenberg and colleagues (1984) described cognitive complexity (i.e., the ability measured by the task) as an important skill for problem-solving which is crucial for success for academic and occupational achievement. Kim and colleagues (2012) stressed the relevance of test scores for occupational success by claiming that the task was developed collaboratively by the faculty of education and business "for the business industry to select the 'right' personnel for positions requiring mathematic skills" (p. 289). Snyder and colleagues (2014) designed task instructions and feedback in a way to increase threats to self-esteem.

They convinced undergraduates at an elite university about their giftedness and provided failure feedback on unsolvable reasoning questions: “It looks like you had some trouble with these problems. You didn’t get any correct . . . usually our gifted participants get at least three of these questions right. I don’t really know if the gifted label actually applies now but let’s just move on to the next gifted task.” (p. 234).

Researchers have sometimes specifically selected tasks tailored to the sample. For example, physical education students or athletes were asked to engage in sport tasks (e.g., aerobic, 10 minute run, or dribbling a basketball through a course of obstacles), assuming that successful performance in these tasks would be important for maintaining their self-image (Coudevylle et al., 2020; Coudevylle et al., 2015; Elliot et al., 2006; Martin et al., 2003). Greenberg (1985) asked undergraduate business students to complete practice questions for a graduate management admission test which was described as measuring managerial potential. It was conveyed to participants that the purpose of the study was to identify future pioneers in the industry for a national project.

Overall, a great variety of tasks have been used to experimentally investigate behavioral self-handicapping of learners. However, it is remarkable that even though these studies examined academic self-handicapping of undergraduate learners, none of the tasks used was common in post-secondary education. Research has yet to experimentally investigate behavioral self-handicapping in settings that approximate realistic learning tasks such as searching information, answering questions on texts, writing a report, and so forth.

Uncertainty in this research was primarily created using feedback manipulations. In this paradigm, experimenters provided non-contingent feedback on task performance (i.e., feedback that does not reflect actual performance) so that it was unclear to participants how the outcome came about and whether it could be repeated in a similar task. Contingency is a crucial component for examining self-handicapping when success feedback is provided but it appears to be less important for failure feedback (e.g., Berglas & Jones, 1978; Kolditz & Arkin, 1982; Tucker et al., 1981). Typically, participants in the experimental group received either success feedback on an unsolvable task (i.e., non-contingent success feedback) or failure feedback while the comparison group was provided with accurate success feedback on their performance. Feedback mainly comprised comparisons of task performance with other participants and indicated

remarkably high or low achievement (Greenberg, 1985; Rhodewalt et al., 1991). For example: “Well you have done exceptionally well. This is one of the best scores I’ve seen to date” (Kolditz & Arkin, 1982) or “Your score falls in the 14th percentile. This means that 86% of students your age taking this test performed better than you” (Tandler et al., 2014).

Little research has compared effects of non-contingent success and failure feedback. Following non-contingent success feedback, learners chose to listen to more distracting music (Rhodewalt & Davison Jr, 1986) and consumed greater amounts of a performance debilitating beverage (Higgins & Harris, 1988) but claimed fewer handicaps compared to learners receiving contingent success feedback (Thompson & Richardson, 2001). However, Thompson (2004) was not able to replicate the effect of feedback on claimed self-handicapping.

There is consensus in the literature that failure feedback has more detrimental effects on participants. After receiving failure feedback, learners reported greater levels of anxiety (Thompson, 2004; Thompson & Hepburn, 2003), reduced satisfaction with their performance (Thompson & Hepburn, 2003; Thompson & Richardson, 2001), and elevated fatigue and sadness (Isleib et al., 1988). Perhaps these negative effects of failure feedback explain why most experiments in the field are incorporating non-contingent success feedback.

After participants receive feedback and anticipate to engaging in a similar or more difficult task at hand, they are offered choices to engage in self-handicapping. Handicaps are described as sparing resources or strategies that benefit performance (e.g., withholding practice), selecting unfavorable performance settings (e.g., distracting music or noise) or conditions (e.g., setting unattainable goals).

The majority of experiments offer participants a practice task which is introduced as increasing performance on an upcoming task. Applications of this approach varied regarding activities provided as the practice task, available practice time, the degree of privacy while practicing and whether experimenters were blind to experimental conditions. For example, Kimble and colleagues (1998) provided learners with the choice to practice a picture matching game and practice as much or as little as they pleased while the experimenter noted the practice time and number of problems

completed. Brown and Kimble (2009) offered learners more privacy while practicing. The experimenter left and was called back by learners when they felt they had practiced enough. Hirt and colleagues (1991) used a similar approach but the experimenter was blind to experiment conditions. After the experimenter noted the time when learners were ready to begin practicing, learners were responsible for choosing when to proceed with the next task and noting their starting time to indicate how long they had practiced. This approach was also replicated using a computer to track start and end time when experimenters and learners clicked a button (McCrea & Hirt, 2011). However, in experiments like this it is questionable whether learners withhold practice to proceed with the experiment and complete it more quickly rather than purposefully selecting this strategy to hinder performance.

Other experiments addressed this issue by setting aside a specific time for practice. Ferrari and Tice, (2000) for example, provided learners with the opportunity to either practice math problems, engage in alternative activities (i.e., make a puzzle or play a video game) or wait for 15 minutes until the experimenter returns and proceeds with the experiment. They measured practice and engaging in alternative activities by observing learners through a one-way mirror and recording their actions every 15 seconds. Wusik and Axsom (2016) used an alternative to practice as means to place social demands on learners. In their study, learners were placed next to a person who appeared to be frustrated while practicing a task that learners successfully completed previously. The experimenter left the room and returned after the practice time was over. Learners were video-taped, and their actions rated by coders blind to experimental conditions. Even though these approaches allow learners to relatively freely choose how to spend their time, only a few studies made use of available technology to gather fine-grained data. In Thürmer and colleagues (2013) learners' actions during their 6-minute practice period were traced by a computer. However, they were not able to practice problems but selected among accessing information about ways to solve different item types (e.g., matrices or classifications). Thompson and Dinnel (2007) used a computer-based practice task and recorded time spent on each practice question (in seconds), the number of correctly solved questions and the number of attempts at each question. However, no alternative activity was offered, and it is unclear whether learners were able to skip practicing and proceed with the experiment.

Music has been introduced to participants as distracting and lowering performance on the task at hand. Across studies, participants chose among four to eight music tapes, mostly with the experimenter witnessing their choices. Labels on the tapes indicated the degree to which each tape would distract, enhance or have no effect on performance. The majority of experiments provided all three options for participants (e.g., Newman & Wadas, 1997; Sanna & Mark, 1995; Shepperd & Arkin, 1989b), while others did not include neutral (Brown & Kimble, 2009; Drexler et al., 1995) or enhancing music tapes as choices (Mello-Goldner & Wurf, 1997; Rhodewalt et al., 1991). In some of these experiments, experimenters created a scenario for participants to select among different music tapes, perhaps to increase credibility of the experiment. For example, Brown and Kimble (2009) instructed experimenters to act as if they had forgotten to assign learners to a sound condition and thus let them select among the music tapes. It should be noted that participants rarely listened to the music tapes neither before nor after making their choice. Experimenters either ended the experiment and debriefed participants, told them they had been selected for the control group and thus did not have to complete this task, or that the tape recorder was broken (Brown & Kimble, 2009; Shepperd & Arkin, 1989a, Shepperd & Arkin, 1989b). Since participants were only able to listen at most once to a selected tape, some researchers used the same music piece for different tape choices; for example, *avant garde* guitar music (Rhodewalt et al., 1991), new age instrumental music (Sanna & Mark, 1995) or classical music (McCrea & Flamm, 2012).

Other variables used to create unfavorable performance settings have included distracting noise or low lighting. Noise was often used to create a baseline condition or as an available handicap that could be chosen but the level of noise was not adjustable (Kim et al., 2010; Mayerson & Rhodewalt, 1988). In Kim and colleagues' (2010) study 1, learners selected among seven tapes ranging from silence to loud noise they planned to listen to while completing math problems. McCrea (2008) offered learners choices to listen to one of seven recordings of traffic and construction noise ranging from distracting to performance facilitating noise, while completing a mathematical test. Lighting was used in a similar way. Learners were able to use a dimmer to darken (described as performance debilitating) or brighten (described as performance enhancing) light in the room before completing a test of intelligence (Snyder et al., 2014).

Greenberg (1985) took a more creative approach to measuring behavioral self-handicapping. He invited learners to choose how easy or difficult a goal they wanted to set themselves for the upcoming task. Learners chose among 21 envelopes containing test questions, with labels ranging from extremely easy (i.e., my goal is to correctly answer 0% of questions) to extremely difficult goals (i.e., my goal is to correctly answer 100% of questions). Selecting a difficult goal indicates self-handicapping behavior as it spoils chances for success while providing an *a priori* excuse for failure.

Other researchers use procrastination as a self-handicapping behavior. Procrastination was predominantly measured by self-report, surveys, vignettes or diaries to indicate how time was spent or make choices from a list of possible distractions (Beck et al., 2000; Cox & Giuliano, 1999; Lay et al., 1992; Park & Brown, 2014; Rhodewalt et al., 1984; Rickert et al., 2014). This approach, however, disguises the extent to which participants accurately reported an intentional dilatory behavior to hamper performance or merely claimed it as a handicap. Ferrari and Tice (2000) observed learners while providing an opportunity to practice or use “time wasters” (i.e., play a video game or make a puzzle). Time spent on activities other than practicing were used as a proxy for procrastination and positively correlated with a self-report measure of procrastination (r = .37). This correlation was stronger for learners who were led to believe that practice has a significant effect on their test performance (r = .44) and not statistically detectable for those who expected practice to be a “fun” activity. This emphasized the importance of introducing a handicap as performance inhibiting when making valid predictions about behavioral self-handicapping. However, it should be noted that learners’ choices to engage in time wasters postponed practice but not the task for which they anticipated failure outcomes. It Is thus unclear how engaging in time wasters is different from withdrawing practice. Lay and colleagues (1992) recognized this issue and cautioned researchers to distinguish procrastination from conceptually similar behavioral self-handicapping strategies such as withdrawing practice, reducing effort or selecting unfavorable preparation or achievement settings. Another limitation of procrastination research is examining procrastination aside from self-handicapping. The majority of procrastination research does not account for aspects central to measuring self-handicapping such as task relevance or contingency of feedback (Bisin & Hyndman, 2020; Pollack & Herres, 2020; You, 2015).

Handicaps can also be more blatant. One example is consuming performance inhibiting substances (e.g., consuming alcohol or drugs) before or while taking a test (e.g., Berglas & Jones, 1978; Higgins & Harris, 1988). In these experiments, samples used were primarily male undergraduate learners or pre-selected samples of males scoring high on measures of drinking behaviors. These selection criteria jeopardize generalizability of empirical findings (e.g., Higgins & Harris, 1988; Kolditz & Arkin, 1982; Tucker et al., 1981). More recent research used broader samples and substituted alcohol or drugs with tea described as performance inhibiting or enhancing (Alter & Forgas, 2007) While the experimenter mostly left the room when participants choose among beverages to consume, drugs or tea were selected with the experimenter present. Choices were predominantly binary (performance enhancing or inhibiting substance) or trinary (performance enhancing, inhibiting or no substance; Alter & Forgas, 2007; Berglas & Jones, 1978; Isleib et al., 1988; Kolditz & Arkin, 1982). In experiments using alcoholic beverages participants' choices were more fluid. When offered alcoholic beverages, participants were able to select the amount they desired to consume. In these experiments, experimenters offer participants a pitcher containing an alcoholic drink and a small cup to pour and drink as many times as they desired (Higgins & Harris, 1988; Tucker et al., 1981).

Self-handicapping choices were primarily offered to participants as either binary (i.e., self-handicapping or no strategy) or trinary choices (i.e., self-handicapping, performance enhancing, or no strategy). Only a few studies allowed participants to select a handicap on a more continuous scale, mainly ranging from performance facilitating to debilitating (e.g., dim the light or select the amount of a beverage to consume). Using these poles to introduce handicaps and alternative choices may help convey implications of strategy selection to participants.

Self-handicapping researchers argue that offering more than one handicap is crucial for generalizing empirical findings beyond one specific handicap (e.g., Cox & Giuliano, 1999; Smith & Strube, 1991). This issue appears to be recognized by a few self-handicapping experimenters who used different handicaps in successive studies in attempts to replicate their studies (e.g., Brown & Kimble, 2009; Kim et al., 2010; McCrea, 2008; McCrea & Flamm, 2012; Tice, 1991). Almost all studies limit participants' choices to exclusively one self-handicapping strategy and only a handful of self-handicapping experiments allow participants to choose among more than one handicap. Alter and

Forgas (2007) offered learners two occasions to self-handicap. Learners are offered the binary choice of a tea introduced as performance enhancing or inhibiting. After selecting and drinking the tea, learners are offered another binary choice of either practicing verbal and logical test questions or reading a book for five minutes. Even though this experiment allowed learners to make choices about two different handicaps, the sequential procedure prohibits predictions about learners' preferences of self-handicapping strategies. It is unclear if findings can be replicated when participants are able to choose among both handicaps and if the sequence is reversed. Tucker and colleagues (1981) allowed learners to choose among two different handicaps. The experimenter left the room for 15 minutes while learners in study one and two could choose among consuming an alcoholic beverage or practice, look at magazines unrelated to the task at hand, respectively. Their findings demonstrated greater tendencies to consume an alcoholic beverage when no alternative handicap (i.e., procrastinate by reading magazines) was available. The authors theorized this was due to providing learners a viable option for enhancing performance. This assumption, however, contradicts extensive evidence for learners' choices to strategically withdraw practice to handicap their performance. Their findings rather demonstrate that providing learners multiple handicaps to choose from influences their decisions to self-handicap.

Another limitation of learners' choices in the majority of self-handicapping experiments is that they do not account for self-handicapping over time, thus denying learners opportunity for metacognitive control to adjust or change their approach to learners. The evolution of behavioral self-handicapping across multiple occasions has yet to be examined.

2.4. Measuring Self-handicapping in Education – Research Questions and Hypotheses

Research examining how self-handicapping relates to academic learning tasks is sparse and mainly based on correlational designs and self-report measures. It has rarely been measured "in action" so far, elevating the need for a new approach to measuring self-handicapping strategies in relation to productive approaches to learning while learners learn. The present study proposes a behavioral measure developed to examine behavioral self-handicapping in education. The proposed measure is tested and psychometrically analyzed to verify if it adequately represents the theoretical qualities of

the construct of behavioral self-handicapping. While self-handicapping experiments so far done have advanced theory, neither the tasks nor the decision-making processes offered approximated authentic learning situations, elevating concern for generalizability and ecological validity. This study addresses these issues by (a) using a task common to post-secondary education, namely, a web-quests involving searching information online to answer questions; and (b) offering multiple occasions for learners to choose among various self-handicapping, neutral or productive learning activities, while unobtrusively tracing learners' self-handicapping behaviors "in action" using nStudy software (Winne et al., 2019; Winne & Hadwin, 2013). This novel approach will yield more complete and fine-grained data gathered on self-handicapping behaviors and can deepen understanding about self-handicapping in education. Specific research questions addressed are:

1. How valid are interpretations of the behavioral measure of self-handicapping?
2. How do choices about approaches to learning by varying study environment and study strategies differ among learners receiving non-contingent versus contingent success feedback?
3. How do learners self-handicap when multiple self-handicapping and productive approaches are offered for learning operationalized as features of the study environment and study strategies?
4. How do learners' choices about the study environment and study strategies change across task iterations?

The present study examines construct validity of interpretations based on the proposed behavioral measure of self-handicapping. To examine the structure(s) of constructs assessing behavioral self-handicapping, Campbell and Fiske's (1959) multitrait-multimethod analysis was used. This approach assesses two categories of construct validity: convergent validity and discriminant validity. Following Campbell and Fiske's (1959) recommendation, more than one method was used to assess behavioral self-handicapping, specifically, trace data generated by the proposed behavioral measure of self-handicapping and the Academic Self-Handicapping Scale (ASHS; Midgley & Urdan, 1995; Urdan & Midgley, 2001), a self-report measure. The ASHS serves as a criterion to investigate convergent validity. The proposed behavioral measure is hypothesized to strongly correlate with self-reported behavioral self-handicapping.

Highlighting precision and the impostor phenomenon are analyzed as criteria for discriminant validity. Neither of these constructs is expected to highly correlate with self-handicapping, a pattern that is hypothesized to be reflected in the data when measuring self-handicapping using the proposed behavioral measure. The behavioral measure of highlighting precision and self-reported impostor syndrome were selected to distinguish whether correlations with self-handicapping are due to a similarity of constructs or measurement approach. See Table 1 for further details. The proposed behavioral measure of self-handicapping is hypothesized to correlate weakly with highlighting precision, weakly to moderately with the impostor syndrome, and strongly with self-reported behavioral self-handicapping.

Table 1. Measures included in the multitrait-multimethod analysis

	Monomethod	Multimethod
Monotrait	Behavioral measure of Self-handicapping trait: behavioral self-handicapping method: traced learner behavior	Academic self-handicapping scale trait: behavioral self-handicapping method: self-report data
Multitrait	Highlighting precision trait: highlighting precision method: traced learner behavior	Clance impostor phenomenon scale trait: impostor syndrome method: self-report data

Note. Monotrait = measures assessing the same construct, multitrait = measures assessing a different construct, monomethod = measures sharing the same method of measurement, multimethod = measures using a different method of measurement.

Strong empirical evidence suggests learners are likely to choose counterproductive approaches to learning after receiving non-contingent success feedback, particularly those who self-report a tendency to self-handicap (e.g., Deppe & Harackiewicz, 1996; Higgins & Harris, 1988; Rhodewalt & Davison, 1986). Tucker and colleagues (1981) contradict these findings. They offered learners choices of a productive and a counterproductive approach to learning. When learners were offered the opportunity to practice for a test or consume an alcoholic beverage to hinder their performance, they chose to practice. However, it should be taken into consideration that learners' choices were limited to practicing or drinking alcohol. It is unclear to which degree this finding is generalizable to other handicaps and less restricted choices. Various handicaps are perceived differently (Hip-Fabek, 2005; McElroy & Crant, 2008; Park & Brown, 2014). Yet it is unclear how a multitude of productive, neutral, or

counterproductive ways of learning influences' learners' choices. The majority of self-handicapping research suggests self-handicappers are likely to select counterproductive approaches to studying. However, learners' choices of productive ways of learning would emphasize benefits of drawing learners' attention to productive approaches to learning.

Self-handicapping is associated with a downward spiral of decreasing academic achievement and motivation, which is theorized to reinforce choices of counterproductive strategies such as self-handicapping over time (e.g., Bandura et al., 1999; L. H. Chen et al., 2009; Elliot & Church, 2003; Kim et al., 2010; Schwinger et al., 2014; Zuckerman & Tsai, 2005). However, self-regulated learning research indicates learners evaluate strategy selection and take metacognitive control by adjusting or changing their approach to regulate their learning (e.g., Winne & Hadwin, 1998). This would suggest increased preference for productive ways of learning across task iterations. Both outcomes have implications for education and strategies to support learners in choosing productive rather than counterproductive approaches to learning.

Chapter 3. Method

A pilot study was conducted to refine the behavioral measure developed to examine behavioral self-handicapping. Think-aloud protocols were followed by open-ended interview prompts: Can you describe what you were asked to do? Why did you choose this strategy? What do you think about the feedback? Why do you think you received this feedback? These data allowed examining the degree to which learners understood implications of choices about studying and could describe strategic rather than random choices. Adjustments to components of the study such as reducing the number of web quests were made as needed and implemented in the present study.

3.1. Pilot Study Participants

Participants for the pilot and the present study, described following, were recruited via flyers distributed to learners at Simon Fraser University.

Participants of the pilot study were 7 (3 female, 4 male) undergraduate learners. The mean age of the sample was *M* = 22.71 years, *SD* = 5.44. The 2 learners who reported they spoke a first language other than English (i.e., Cantonese) had 2 and 15 years, respectively, of schooling in which English was the primary language of instruction. Major foci for their degree programs spanned faculties: 2 in the Faculty of Arts and Social Sciences, 1 in the Faculty of Education, 1 in the Faculty of Applied Science, 1 in the Faculty of Sciences, and 1 in the School of Business. One learner had not declared a major yet. On average, learners had taken 19 courses over 2 years and 4 months of post-secondary education.

3.2. Present Study Participants

The sample for the present study included 68 undergraduate learners (36 female, 32 male). The mean age of learners was *M* = 20.35, *SD* = 1.85. In this sample, 42 first learned to speak a language other than English e.g., Cantonese, Mandarin, Hindi, Panjabi, Korean. These learners had on average 11 years and 2 months of schooling in which English was the primary language of instruction (*SD* = 5.62). The sample was recruited from all faculties (see Table 2). On average, learners had taken 26 post-

secondary courses and began their post-secondary education in 2016. For a comparison of demographics between the comparison and experimental group, see Table 3. Learners experiencing technical difficulties during the experiment or who doubted that performance on the web quest is a reliable indicator for future success or failure in university studies were removed from the sample. The three learners for whom this manipulation of task value failed emphasized they believed other aspects such as writing skills, study habits or health are more important. One learner did not complete the study.

Table 2. Faculties of declared majors for all learners, comparison group (CG) and experimental group (EG).

Faculties	All (n = 68)	CG (n = 35)	EG (n = 33)
Faculty of Applied Sciences	14	10	4
Faculty of Arts and Social Sciences	13	2	11
Faculty of Communication, Arts and Technology	5	2	3
Faculty of Education	4	2	2
Faculty of Environment	2	1	1
Faculty of Health Science	4	3	1
Faculty of Science	11	6	5
Beedie School of Business	9	5	4
Not yet declared	6	4	2

Table 3. Demographics of learners in the comparison group (CG) and experimental group (EG).

		Gender		Age		English proficiency		Post-secondary education	
	n	female	male	*M*	*SD*	EAL	YSE	courses	begin
CG	35	19	16	20.37	1.56	15	11	23	2017
EG	33	17	16	20.33	1.87	10	11	28	2016

Note. EAL = learners who speak English as an additional language, YSE = years of schooling in which English was the primary language of instruction, calculated for learners who speak English as an additional language.

3.3. Materials

3.3.1. Motivated Strategies for Learning

Three subscales of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, 1991) were administered: efficacy for learning and performance (ELP; 8 items), metacognitive self-regulation (MSR; 12 items), and time and study environment (TSE; 8 items). Items were presented in random order mixed with items measuring behavioral self-handicapping to disguise presence of the self-handicapping items. Learners were asked to rate each item on a 7-point rating scale ranging from 0 = not at all true of me to 6 = very true of me. Wording of Items in the efficacy of learning and performance subscale was adjusted to focus on learners' beliefs about their ability to succeed in a web quest rather than in a class or course. Sample items were: "I believe I will receive excellent marks for answering questions about texts I read." (ELP), "I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying." (MSR), and "I usually study in a place where I can concentrate on my course work." (TSE). Internal consistencies for these subscales were $\alpha_{ELP} = .90$, $\alpha_{MSR} = 70$, $\alpha_{TSE} = .04$. The subscale time and study environment management strategies was excluded from further analyses due to low internal consistency.

3.3.2. Behavioral Self-handicapping

The Academic Self-Handicapping Scale (ASHS: Midgley & Urdan, 1995; Urdan & Midgley, 2001) was used to measure behavioral self-handicapping. Learners were asked to rate six items on a 7-point rating scale, ranging from 0 = not at all true of me to 6 = very true of me. Wording of items was adjusted to meet the format of other questionnaires included in this study i.e., items were phrased more actively by using personal pronouns such as I, me, or my rather than some students, they, or them (sample item: "I sometimes put off doing my school work until the last minute so that if I don't do well on my work I can say that is the reason."). Internal consistency of this scale was acceptable, $\alpha = .72$. High scores on the ASHS reflect a strong tendency to practice behavioral self-handicapping.

Behavioral self-handicapping was assessed as learners tackled three web quests in the form of time-stamped trace data gathered from participants' interactions with

features in the self-handicapping panel in nStudy (See Figure 1). Learners were offered choices in three categories describing consequences of engaging in a behavior: self-handicapping, conducive, and no effect on studying or performance. Learners were able to make multiple choices at any time. Behavioral self-handicapping was operationalized by choosing options that were described to learners as behaviors that would make studying more challenging. For example, a learner could self-handicap by clicking on the play button to listen to “self-handicapping” music, asking the research assistant for “self-handicapping” tea and select this tea in the panel, or procrastinate by browsing Amazon. Access to webpages was limited to the survey, where questionnaires and web quests were implemented and the specified procrastination webpages. Three different kinds of organic mixed herbal and fruit teas were prepared and served by research assistant upon request. Each tea pot was labelled as tea 1, 2 or 3. Tea was served temperate and in moderate amounts, so learners were able to make multiple tea selections. Tea selections were limited to one kind of tea per web quest to elevate credibility of described effects of each tea.

Popup ads included a selection of 40 advertising videos for a wide range of products (e.g., groceries, beauty products, travel, toys), with an average length of 38 seconds. By default, ads popped up every 55 seconds in a small new window, partly blocking the learners’ view of the web quest. Learners were able to block ads or use a slider to regulate the frequency of popup ads from rare (i.e., every 4 min.), through occasionally (i.e., every 48-60 sec.) to frequently (i.e., every 30 sec.). nStudy traced the URL of each ad, the time when it popped open and was closed, as well as tab switching signaling the learner put the ad in the background.

Screen brightness was customizable by learners using a slider from dark (i.e., described as performance conducive), neutral, or bright (i.e., described as performance inhibiting). The self-handicapping panel recorded the time stamp and value of screen brightness changed by the learner.

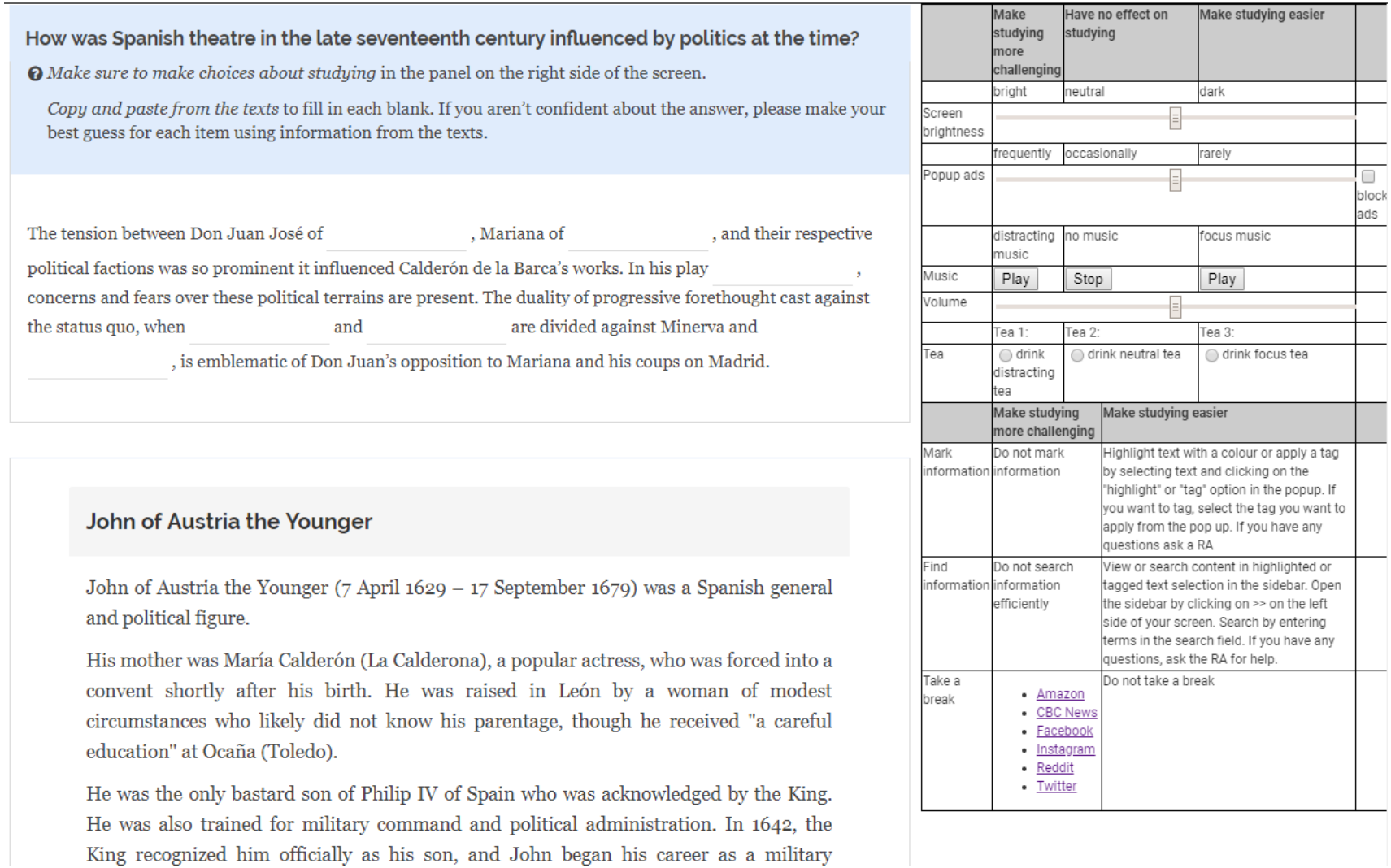

Figure 1. Self-handicapping panel offering learners choices of self-handicapping, neutral or productive approaches to learning while completing the web quests.

Focus music was selected following recommendations from three certified meditation therapists and yoga instructors at Simon Fraser University. It was a song of 1.5 hours duration, *Healing harp and thunderstorm: Harp music with thunderstorm for therapy, sleep, meditation, healing & relaxation* from the Sound Healing Center. A survey was conducted to identify music that undergraduates perceive as distracting. Six learners ranked a list of 10 songs from a wide range of musical genres (e.g., hip hop, swing, punk, reggaeton, rock) from 1 = most distracting to 10 = least distracting. A heavy metal band album by System of a Down was ranked as most distracting, with an average rank of $M = 2.33$ and $Md = 1.5$, followed by an album by the progressive rock band The Mars Volta ($M = 4$, $Md = 3$). "Self-handicapping" music were songs from the album Mezmorize from System of a Down excluding songs with expletive language. During web quests, learners were able to listen to either kind of music or no music. nStudy recorded a time stamp when learners selected to play and stop each kind of music.

Procrastination webpages were selected from the most prominent webpages to be likely of interest to learners (*Website Ranking: Top Websites Rank In The World - SimilarWeb*, 2019). Webpages included were Amazon, CBC News, Facebook, Instagram, Reddit and Twitter. None of these webpages included content related to the web quests. A whitelist with these webpages and the survey webpage was created to block access to other webpages e.g., search engines. nStudy traced the webpage displayed on the screen, and a timestamp when a page was opened, closed, or put into the background/foreground.

In the study view of nStudy, learners were able to mark text selections with a colour (highlight) and apply one of the following tags: helpful, required, definition or example (see Figure 2). Marked and/or tagged text selections were listed in a sidebar that learners were able to open or close. In this sidebar learners could view the number of marked/tagged text selections made so far, search for content in these text selections or click on a specific text selection to scroll the display to view that selection in the text of a webpage. Learners were also able to delete text selections and tags they created. nStudy traced when text was selected, the selected text, the tag applied if any, when a text selection was clicked to view it, to delete it or searched. Search terms learners entered were also recorded as well as timestamps for opening and closing the sidebar.

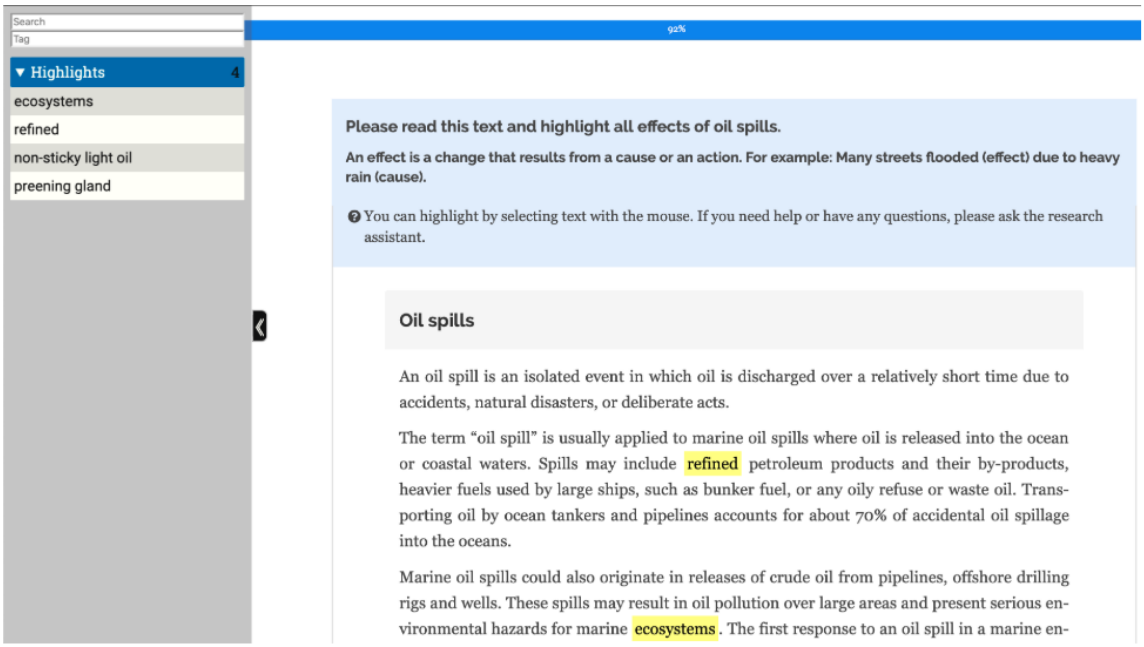

Figure 2. Study view allowing learners to create highlights, tags and search for tags or content within highlighted/tagged text selections.

The timestamp and URL of the webpage when the study view and self-handicapping panel was accessible for learners was also traced. This data affords distinguishing learners' actions between each of the three web quests.

3.3.3. Web Quests

Three web quests were developed based on recently completed dissertations on topics with which undergraduate learners are not likely familiar with (Brady, 2017; Wilson, 2017; Zanowski, 2017). Topics were selected in these areas to account for different interests of learners. Web quests were open-ended questions: (a) How was Spanish theatre in the late seventeenth century influenced by politics at the time? (b) How is gender assigned in Yeri? and (c) How do Antarctic open-ocean polynya influence the abyssal ocean?

Each web quest was to be answered by copying and pasting information from the texts available to fill in five/six blanks. Texts were developed based on adjusted and combined brief excerpts from Wikipedia articles and the three dissertations (see Appendix A). The texts were 820 – 895 word in length (M_{CG} = 862 words, M_{EG} = 879 words) and mainly identical for the two groups. Content of texts for the two groups

differed only by 26% (i.e., approximately 1-2 paragraphs of text). Texts available to the comparison group (CG) provided sufficient information to fill in all blanks whereas texts available to the experimental group (EG) supplied information to fill in only one or two of the blanks. To reduce possible frustration of learners in the experimental group, information available was closely related to the topic. For example, texts about Yeri available to the comparison group included explanations on how gender is assigned in the Yeri language, while those available to the experimental group explained how gender is assigned in the Ket or Zande language. While working on each web quest, learners were able to make choices about studying in the self-handicapping panel and use the study view in nStudy.

3.3.4. Rating of Choices in the Self-handicapping Panel

Prior to the web quests, learners were given opportunity to experience and rate each choice available in the self-handicapping panel. The following items were developed to gauge learners' cost/benefit expectations of each choice. Participants were asked to rate how true statements about each choice were of them, on a 6-point rating scale ranging from 1 = not at all true of me, to 7 = very true of me. For example, after offering opportunity to listen to "focus" and "self-handicapping" music for 15 seconds, learners were asked to rate following statements: "Listening to "focus" music makes studying and achieving good outcomes easier" and "Listening to "distracting" music makes studying and achieving good outcomes harder". Ratings were reverse coded for self-handicapping choices and summed by category. For example, the score of ratings for listening to music is the sum of listening to focus music plus listening to distracting music reversely coded for each learner. Higher scores indicate more extreme ratings of productive and self-handicapping choices.

3.3.5. Prior Knowledge

To gauge learners' prior knowledge about the 3 topic areas of the web quest task, the following items were developed. First, learners were asked to rate how familiar they are with each topic on a 3-point rating scale (0 = not at all familiar, 1 = somewhat familiar, 2 = very familiar). A sample item is, "How familiar are you with open-ocean polynya?" Learners who reported they were not familiar with a topic proceeded with the next question. Learners who report they were somewhat or very familiar with a topic

were asked to demonstrate their knowledge by elaborating on it in a textbox. A sample item is: “What are the three things about open-ocean polynya you would mention to a friend who is not familiar with this topic? The prior knowledge scores ranged from 0 (not familiar) to 5, where points equal the participant’s rating plus 1 point for each reasonable or correct entry in the textbox. High scores on this measure reflect high prior knowledge about the topic areas of a web quest task.

3.3.6. Claimed Self-handicapping

Claimed self-handicapping was assessed using a list of 14 factors that describe a handicap and a textbox to enter an additional factor (Snyder et al., 2014; Thompson & Richardson, 2001). Learners were asked to rate on a 7-point rating scale ranging from 0 (not at all likely) to 6 (very likely) how likely each factor would negatively influence their performance on the upcoming web quest. Factors can be described as aspects of physical well-being (headache, fatigue, feeling sick or injured, feeling tired, feeling strange, and a lack of sleep) and psychological well-being (general test anxiety, feeling “burned out”, worried about money, worried about relationship with friends or boyfriend/girlfriend, lack of support from friends, argument with close friend, boyfriend/girlfriend or family member, difficulty coping with school work, and feeling overwhelmed). High scores reflect high tendencies to claim handicaps. Internal consistencies were good, $\alpha_{WQ1} = .95$, $\alpha_{WQ2} = .94$, $\alpha_{WQ3} = .94$.

3.3.7. Justification of Choices

After completing the web quests, learners in the present study were given opportunity to explain choices made in the self-handicapping panel. The following item was developed to elevate credibility of the study: “If you want, you can share why you made choices about studying when you were working on the web quests.” A list of choices was provided as a reminder. Learners were invited to respond to the item in a textbox.

3.3.8. Highlighting Precision

The highlighting task, adapted from Marzouk (2018), is a behavioral measure designed to assess learners’ studying activity. Learners are asked to read a 1102 words

(56 sentences) text about oil spills and highlight all effects of oil spills. Effects appeared in18 sentences including 49 idea units as classified by Marzouk (2018). A sample sentence is: “Improper waste management of oil facilities located on agricultural lands could lead to soil and water contamination.”. An idea unit is operationalized as highlighted when at least one word within an idea unit is highlighted nStudy unobtrusively traced text learners selected for highlighting. Highlighting precision was operationalized as the number of highlighted idea units on effects of oil spills divided by the total number of highlighted idea units (adapted from Yue et al., 2015). Scores close to 1 reflect precise highlighting. This measure was used to account for discriminant validity of the new measure of behavioral self-handicapping.

3.3.9. Impostor Syndrome

The Clance Impostor Phenomenon Scale (CIPS; Clance, 1985) was designed to measure the degree to which impostor feelings are experienced. Its role in this study was to provide opportunity to determine discriminant validity. This self-report measure presents 20 items to be rated on a 7-point rating scale ranging from 0 = not at all true of me to 6 = very true of me. Items are adapted to ask about school rather than work contexts (e.g., “Sometimes I feel or believe that my success in my life or in my studies has been the result of some kind of error.”). Internal consistency of the CIPS (α = .94) were good. High scores on the CIPS reflect that learners experience strong impostor feelings

3.3.10. Task Importance

The following item was developed as a manipulation check to gauge learners’ perceived importance of the web quest task: “Do you think that skills needed to do well on a web quest task such as searching online for information to answer questions, identifying main ideas in texts, critical thinking, and retrieving relevant information are important for being successful in university studies?” Learners were asked to select “yes” or “no” from a radio button list. Learners selecting “yes” proceeded with the next question while learners who responded “no” were asked to elaborate on this choice in a textbox.

3.4. Psychometric Analysis

Multitrait-multimethod analysis was used to examine the structure(s) of constructs assessing behavioral self-handicapping. More than one method was used to assess behavioral self-handicapping: trace data and the ASHS, a self-report measure. The ASHS thus serves as a criterion to account for convergent validity (Campbell & Fiske, 1959). Highlighting precision and the impostor phenomenon are analyzed as criteria for discriminant validity. See Table 1 for further details.

Even though reliability is an important psychometric property of a measure, trace data challenge traditional approaches of estimating reliability. Psychometric analysis in this study focuses thus on estimates of validity. Methods to assess reliability such as test-retest reliability or parallel forms have a long tradition in psychometrics, particularly in test theory and are thus primarily developed and widely used for psychological test scores in the form of self-report questionnaires or surveys (Geisinger et al., 2013; Shrout & Lane, 2012). Advances in technology afford collecting considerably more fine-grained data to trace learning as it happens. These new measurement approaches challenge traditional methods to analyze reliability (Gibson & Webb, 2015). While the concept of reliability remains important, new measurement approaches call for an update of methods estimating reliability. Concepts like internal consistency or test-retest reliability do not necessarily apply to trace data.

Internal consistency assesses the degree to which items of a test measure the same content (Geisinger et al., 2013; Shrout & Lane, 2012). It can be estimated using Cronbach's alpha, a method that examines the extent to which items on a single test are not statistically independent. High values of Cronbach's alpha indicate good internal consistency of test scores. Although it is mathematically possible to correlate different ways of self-handicapping (e.g., counts of events where a learner listens to "self-handicapping" music and counts of choices to increase the frequency of pop up ads), it is unreasonable to assume learners select all available ways of self-handicapping when multiple actions are provided such as: listening to "self-handicapping" music, increasing screen brightness, increasing the frequency of pop up ads and procrastinating by browsing different webpages while drinking "self-handicapping" tea. While these different expressions of handicapping are designed to measure the same latent variable of self-handicapping, they are made available to allow learners to exercise preferences and

may not be comparable. Prior research indicates that different ways of self-handicapping are perceived differently (Cox & Giuliano, 1999; Hip-Fabek, 2005; Smith & Strube, 1991) and that learners have different preferences for various approaches to self-handicapping (Rhodewalt et al., 1984; Tucker et al., 1981). This suggests the concept and measurement approach of internal consistency might not apply to data tracing self-handicapping behavior.

Test-retest approaches to estimating reliability gauge the stability of scores obtained by the same individual across test administrations. Equivalence forms of reliability compare scores of parallel test items presented in a single test (Geisinger et al., 2013; Shrout & Lane, 2012). A high correlation of scores across the tests/test forms indicates reliability. In the new measurement approach used here, a web quest could be viewed as a repeated measurement of self-handicapping from the perspective of parallel items. However, the three web quests are not equivalent in content nor is it reasonable to assume test conditions are equal among the three web quests. Taking psychological interpretations of receiving non-contingent feedback and effects such as carryover effects or placebo effect into account, it is unlikely that inferences drawn from the second or third web quest reflect those in the first web quest.

The proposed behavioral measure operationalizes self-handicapping behavior as selecting approaches to studying, introduced as making studying and achieving good outcomes more challenging (see section 3.3.2 for more details). This means the consistency of self-handicapping scores is reflected by binary actions of learners (i.e., clicking on a button/slider or not). Assuming the learning software used in this study records students' interaction with the software accurately and learners are able to use a computer mouse and interact with the software, it is likely that trace data indicating learners' interaction with the software is a relatively reliable representation of their choices about studying. According to Winne (2020b) computers trace behavior perfectly, however, learners' intentions to interact with the software can vary. To account for accurate recording of the software it went through rigorous testing and multiple feedback-loops and was released for pilot testing when five graduate research assistants judged it to be functional and accurate. The degree to which learners' interaction with the software is consistent with their choices is examined in the pilot study and open-ended questions asking about study strategies that make studying harder/easier were used in the present study. Learners were also asked to rate each

approach to studying offered in this study to indicate how helpful or hindering it would be for themselves. This approach triangulates data about proxies for learners' intentions to engage with the software, which elevates the likelihood for reliable interpretations based on the proposed behavioral measure (Winne, 2020b).

3.5. Procedure

The computer-based study was carried out in the Educational Psychology laboratory at Simon Fraser University using the survey software LimeSurvey and the learning software nStudy. nStudy is an extension to Google Chrome that serves as an online learning environment that unobtrusively traces learners learning activities (Winne et al., 2019). Two views were provided in nStudy: (a) the study view and (b) the self-handicapping panel which was developed for this study (see Figure 1, Figure 2). No more than one (pilot testing), and four (main study) learner(s) completed the study at the same time. To create privacy and a quiet workspace for each learner, dividers were placed between desks and learners in the present study were asked to wear headphones.

After providing informed consent, learners completed self-report questionnaires about demographics. They were then asked to answer items about behavioral self-handicapping, mixed among items from the Motivated Skills for Learning Questionnaire (MSLQ; Pintrich, 1991) to disguise purpose of the study. Learners were led to believe the study sought to better understand why learners select specific ways of studying. Next, learners completed questions of their prior knowledge relating to the subsequent web quest task. Learners were asked to complete three web quests (i.e., seeking answers to an open-ended question by searching a set of preselected texts online). To increase task value, performance on web quests was described as a reliable indicator of learners' future success or failure in academic programs:

> Research shows that skills needed to do well on a web quest task, such as searching online for information to answer questions, identifying main ideas in texts, critical thinking, and retrieving relevant information are very important in university studies. Your performance on each web-quest is thus a relatively accurate indicator of future success or failure in university studies.

Each possible choice in the self-handicapping panel was described to learners as hindering, improving, or having no effect on studying and performance. Learners were also given opportunity to experience each of the choices (e.g., listen to “focus” music and “self-handicapping” music) and describe how likely each choice makes studying and achieving good outcomes easier or harder. Learners in the pilot study provided verbal descriptions while learners in the present study rated each of these statements on a 7-point rating scale ranging from 0 = not at all true of me to 6 = very true of me.

Before searching for an answer to each web quest, learners were given opportunity to claim a handicap. Next, learners were asked to complete one of the three web quests, make choices in the self-handicapping panel, and use features of the study view. In the pilot study, learners explained for each web quest how important it was for them to succeed, how confident they were to do well and how challenging it was. After making a choice in the self-handicapping panel or using a feature of the study view, learners in the pilot study were interrupted and asked to explain why they made this choice and what consequence they expect it to have. Learners in the present study completed each web quest without interruption.

To blind experimenters to experiment conditions, the survey program randomly assigned learners to one of two groups: experimental or comparison group. In contrast to the comparison group, texts available to the experimental group did not contain sufficient information to answer the web quests.

After each search, all learners received pre-defined success feedback, thus manipulating contingency of feedback for the two groups. Feedback stated that learners did very well on this web quest, their answer was better than 85–93% of all the learners who did this task so far and were reminded that their very high score is a strong predictor of future success in university studies. Feedback was displayed on the screen of each learner to allow for privacy.

Upon completion of the web quest task learners were invited to explain why they made specific choices in the self-handicapping panel and whether they believed that performance on web quests was a reliable predictor for future success in academic studies, complete a highlighting task and the Clance Impostor Phenomenon Scale

(CIPS, Clance, 1985). All learners were thoroughly debriefed and received monetary compensation for their time and effort.

Chapter 4. Results

Data were analyzed using R and R packages (R Core Team, 2020). A type I error rate of 0.05 was set to identify statistically detectable effects throughout the study.

Data about self-handicapping were included in two scales. First, self-handicapping events were summarized as a binary variable for each web quest, i.e., 1 if at least one self-handicapping event occurred and 0 if it did not. Second, self-handicapping was operationalized as the time spent engaging with each self-handicapping, neutral or productive study strategy in relation to the time spent on each web quest. Tea, highlights and tags are reported as finite count data. Learners' choices about tea were limited to one kind of tea per web quest.

4.1. Tuning of the Present Study

Time to complete the pilot study often exceeded the target of one hour, so the number of web quests in the present study was reduced from five to three. This change allowed learners to complete the experiment within approximately one hour, *M* = 67 min., *Md* = 65 min., *SD* = 20. The web quests were selected based on learners' ratings of importance to do well on the web quests. Web quests were presented in ascending order of the overall rated difficulty by learners in the pilot study. Asking these learners about their personal rating of the effectiveness of each choice in the self-handicapping panel revealed individual differences. Accordingly, rating of each choice was implemented as rating scales in the questionnaire. Pilot testing was concluded as learners completed the experiment in approximately one hour and described strategic rather than random choices on the self-handicapping panel. For example, a learner described their choice to block infrequently appearing advertisement videos as follows: "…I blocked ads because they were very distracting and difficult to navigate away from."

4.2. Manipulation Checks

Descriptive statistics are reported in Table 4 for the experimental and comparison groups on self-reported self-handicapping, self-efficacy, management of their time and study environment, metacognitive strategies, experiences of the impostor syndrome, and

their highlighting precision. The null hypothesis testing differences between means of these two groups was examined using an independent groups *t*-test, adjusted for multiple testing. None of these tests indicated statistically detectable differences between the comparison and experimental group.

All learners included in this study reported they believed performance on web quests is a reliable indicator of future success or failure in university studies. Two learners reported prior knowledge about endangered languages in general, particularly reasons why languages become endangered and associated challenges. This, however, was not part of the web quests. The web quest on the endangered language spoken in Papua New Guinea focused on gender assignment in the Yeri language. Prior knowledge demonstrated by these learners did not advantage them for web quests in this study. These learners were not excluded from this study.

Table 4. Comparison of learners in the comparison versus the experimental group.

	Comparison group			Experimental group		
	M	*Md*	*SD*	*M*	*Md*	*SD*
Self-reported self-handicapping	15.097	14	6.085	15.276	15	6.307
Impostor syndrome	86.129	86	24.564	87.000	85	27.949
Highlighting precision	0.681	0.692	0.220	0.654	0.727	0.230
Meta-cognitive strategies	50.226	50	10.829	53.517	56	9.241
Academic self-efficacy	39.161	41	10.322	42.862	43	5.842
Time and study environment strategies	31.871	31	9.025	31.483	32	7.872

All learners used the self-handicapping panel. However, one learner had a missing value in the first web quest and was thus excluded from cluster analyses reported later. Eight learners, four in the comparison group and four in the experimental group, failed to create highlights in the highlighting task. These learners were excluded from analyses involving the variable highlighting precision, reducing the sample size for these analyses from n = 68 to n = 60.

4.3. How Valid are Interpretations of the Behavioral Measure of Self-handicapping?

Campbell and Fiske's (1959) multi-trait multi-method analysis (MTMM) was used to examine the research question about validity of interpretations of the behavioral measure developed to examine behavioral self-handicapping. The MTMM model includes three traits: self-handicapping, highlighting precision, and the impostor syndrome. Traits were operationalized using two methods: self-report surveys (i.e., academic self-handicapping scale and Clance impostor phenomenon scale) and trace data generated through learners' interaction with the self-handicapping panel and text marking using features of nStudy. Following Campbell and Fiske's (1959) suggestions, I examined associations between traits and methods using regression and correlation analyses. Self-handicapping was operationalized as interactions with features described to learners as making studying harder, and no or reduced interaction with features described as making studying easier. More specifically, a binary variable described engagement with the self-handicapping panel, coded as 0 if no self-handicapping choice was selected, and 1 if at least one self-handicapping choice was selected in the panel.

Several binomial regression analyses were conducted to examine associations between the binary dependent variable self-handicapping measured by the behavioral measure and independent variables. Independent variables were self-reported academic self-handicapping, self-reported impostor syndrome, and traced highlighting precision (see Table 1 for an overview). Neither regression analysis yielded statistically detectable results. This suggests a need for a more granular operationalization of self-handicapping.

Self-handicapping was therefore operationalized in finer grain as each student's time engaged with each self-handicapping, neutral, or productive study strategy in relation to time spent on each web quest. Tea, highlights, and tags are included as finite count data with choices of tea being limited to one kind of tea per web quest such that the maximum score on the variable tea was 3 for each learner.

Multiple regression analyses used self-reported self-handicapping, impostor syndrome and highlighting precision as predictors and each of self-handicapping or productive study strategies as an outcome. Visual inspection of residuals indicated

multiple regression was appropriate. Correlations among predictors did not suggest multicollinearity would be an issue in these regression analyses. Self-reported self-handicapping was negatively correlated with highlighting precision (r = -.22, p = .003) and positively associated with self-reported impostor syndrome (r = .41, p < .001). Highlighting precision was not statistically detectable correlated with impostor syndrome.

Multiple regression analysis identified the impostor syndrome as a statistically detectable predictor of time spent working with infrequent popup ads in the first web quest, see Table 5. Predictors did not account for much variance: R^2 = .08, adj. R^2 = .03.

Table 5. Multiple regression estimates for predictors of time tolerating infrequent popup ads in web quest one.

	β	*SE*	*t*	*p*
Intercept	0.227	0.137	1.660	.103
Self-handicapping	0.008	0.005	1.523	.133
Impostor syndrome	0.002	0.001	2.088	.041
Highlighting precision	0.033	0.128	0.260	.796

Instead of the time spent highlighting and tagging, the number of highlights and tags created was used to measure these outcome variables. Zero-inflated Poisson regression was used to analyze these data as less than 50% of learners created text selections or tags on either web quest. More specifically, of the 68 learners, highlights were created by 29 learners in the first web quest, 31 in the second web quest and 20 in the third web quest. Because only two, five and four learners tagged text on the first, second and third web quests, respectively, regression analyses were conducted only for highlighting. Across web quests, highlighting was associated with self-reported impostor syndrome but not with self-reported self-handicapping or highlighting precision, see Table 6.

To examine method bias as suggested by Campbell and Fiske (1959) correlations were examined for variables sharing a method (i.e., monomethod): traced self-handicapping and highlighting precision. Highlighting precision was weakly negatively correlated with choices to complete the third web quest (i.e., open-ocean polynya) with the default popup ad frequency (r = -.262, p = .043). Correlations between

highlighting precision and any other self-handicapping choice in either of the three web quests were not statistically detectable.

Table 6. Zero-inflated Poisson regression analyses predicting highlighting using self-reported self-handicapping, impostor syndrome, and traced highlighting precision as predictors.

	β	*SE*	*Z*	*p*
First web quest				
Intercept	0.306	0.337	0.909	.364
Self-handicapping	0.004	0.016	0.237	.813
Impostor syndrome	0.017	0.004	3.940	.001
Highlighting precision	-0.070	0.295	-9.237	.812
Second web quest				
Intercept	-0.165	0.388	-0.425	.671
Self-handicapping	0.005	0.019	0.271	.786
Impostor syndrome	0.019	0.005	4.079	.001
Highlighting precision	-0.265	0.352	-0.752	.452
Third web quest				
Intercept	0.833	0.559	1.391	.164
Self-handicapping	-0.023	0.022	-1.013	.311
Impostor syndrome	0.012	0.005	2.171	.030
Highlighting precision	0.010	0.583	0.016	.989

Neither self-handicapping trace was statistically significantly correlated with self-reported self-handicapping. In the first web quest, the impostor syndrome was negatively correlated with the time spent on procrastination webpages $r = -.305$, $p = .019$). The impostor syndrome was also correlated with the number of highlights created in the second web quest, $r = .334$, $p = .005$, but not with any of the other choices in the self-handicapping panel. This finding, however, should be interpreted with caution because only three of the 68 learners procrastinated on the first web quest.

4.4. How do Choices in the Self-handicapping Panel differ among Learners Receiving Contingent versus Non-contingent Success Feedback?

To examine the research question about how learners receiving contingent (comparison group) versus non-contingent success feedback (experimental group) claimed or fabricated handicaps differently, two methods were used: logistic regression and *t* test. To identify statistically detectable differences between comparison and experimental groups' means *t* tests were used. Logistic regression reveals contributions each of several independent variables make to differentiating learners' membership in the comparison or the experimental group. The binary variable group affiliation (0 = comparison group, 1 = experimental group) was the dependent variable. Independent or predictor variables included were: (1) claimed self-handicapping, (2) procrastination, (3) highlighting, (4) tagging, (5) focus music, (6) self-handicapping music, (7) focus tea, (8) neutral tea, (9) self-handicapping tea, (10) infrequent popup ads, (11) moderately frequent popup ads, (12) frequent popup ads, (13) focus screen brightness, (14) neutral screen brightness, (15) self-handicapping screen brightness. Each of these variables was included for each web quest, e.g., tagging in web quest one, tagging in web quest two, and tagging in web quest three as a separate variable, resulting in an overall number of independent/predictor variables for the aforementioned analyses of 45. See Tables 7 to 11 for descriptive statistics for these variables. Visual inspection of the data determined logistic regression and *t* test was appropriate and correlation analyses indicated multicollinearity would not be an issue.

Table 7. Handicaps claimed per web quest in the comparison and experimental group.

	Comparison group			Experimental group		
	M	*Md*	*SD*	*M*	*Md*	*SD*
Claimed handicaps on WQ 1	51	55	21.142	56.690	41	25.429
Claimed handicaps on WQ 2	46.645	50	23.154	38.655	29	23.532
Claimed handicaps on WQ 3	41.935	40	20.568	37.897	25	24.950

Note. WQ 1 = first web quest (i.e., Spanish theatre), WQ 2 = second web quest (i.e., Yeri language), WQ 3 = third web quest (i.e., open-ocean polynya).

Table 8. Self-handicapping choices in the comparison and experimental group per web quest.

	Comparison group			Experimental group		
	M	*Md*	*SD*	*M*	*Md*	*SD*
Time procrastinated						
Web quest 1: Theatre	0.02	0.00	0.10	0.03	0.00	0.12
Web quest 2: Yeri	0.13	0.00	0.77	0.18	0.00	1.05
Web quest 3: Polynya	0.07	0.00	2.99	0.00	0.00	0.00
Time listening to distracting music						
Web quest 1: Theatre	11.85	0.00	27.71	6.89	0.00	23.95
Web quest 2: Yeri	6.11	0.00	19.44	0.01	0.00	0.08
Web quest 3: Polynya	7.07	0.00	23.39	0.00	0.00	0.00
Time worked with frequent popup ads						
Web quest 1: Theatre	2.89	0.00	16.86	5.24	0.00	17.97
Web quest 2: Yeri	3.05	0.00	17.00	0.00	0.00	0.00
Web quest 3: Polynya	1.17	0.00	6.09	0.85	0.00	4.89
Time worked with bright screen						
Web quest 1: Theatre	2.95	0.00	15.46	0.03	0.00	0.11
Web quest 2: Yeri	0.11	0.00	0.55	0.00	0.00	0.00
Web quest 3: Polynya	2.94	0.00	16.96	0.00	0.00	0.00

Note. Variables describe the time spent studying with a self-handicapping choice about learning in relation to time spent on web quest, with a total time on web quest = 100.00%.

Table 9. Neutral choices about learning in the comparison and experimental group per web quest.

	Comparison group			Experimental group		
	M	*Md*	*SD*	*M*	*Md*	*SD*
Time worked with neutral popup ads						
Web quest 1: Theatre	18.16	9.63	25.74	15.74	11.27	18.98
Web quest 2: Yeri	11.59	2.46	23.60	18.62	2.86	32.17
Web quest 3: Polynya	15.95	3.05	28.18	17.79	7.59	29.13
Time worked with neutral screen						
Web quest 1: Theatre	91.80	100	25.72	99.93	100	0.16
Web quest 2: Yeri	99.78	100	1.15	96.98	100	17.10
Web quest 3: Polynya	92.32	100	25.39	99.98	100	0.06

Note. Variables describe the time spent studying with a neutral choice about learning in relation to time spent on web quest, with a total time on web quest = 100.00%.

Table 10. Productive choices about learning in the comparison and experimental group per web quest.

	Comparison group			Experimental group		
	M	*Md*	*SD*	*M*	*Md*	*SD*
Time listened to focus music						
Web quest 1: Theatre	47.42	54.90	48.35	32.73	0.--	43.92
Web quest 2: Yeri	46.52	27.74	47.63	30.09	0.00	43.14
Web quest 3: Polynya	38.52	0.00	45.11	28.68	0.00	44.31
Time worked with infrequent popup ads						
Web quest 1: Theatre	81.86	90.37	25.75	80.05	88.92	27.76
Web quest 2: Yeri	88.48	97.28	23.55	87.24	97.37	24.58
Web quest 3: Polynya	83.48	96.37	28.43	84.32	92.41	25.69
Time worked with dark screen						
Web quest 1: Theatre	5.25	0.00	21.31	0.02	0.00	0.08
Web quest 2: Yeri	0.10	0.00	0.60	3.00	0.00	17.10
Web quest 3: Polynya	4.73	0.00	19.64	0.00	0.00	0.00
Number of created highlights						
Web quest 1: Theatre	2.76	0.00	6.67	3.18	0.00	5.20
Web quest 2: Yeri	2.15	0.00	4.05	2.33	0.00	4.07
Web quest 3: Polynya	1.09	0.00	2.63	1.79	0.00	2.86
Number of created tags						
Web quest 1: Theatre	0.06	0.00	0.34	0.21	0.00	1.22
Web quest 2: Yeri	0.71	0.00	3.43	1.36	0.00	7.83
Web quest 3: Polynya	0.50	0.00	2.58	0.48	0.00	2.18

Note. Variables describe the time spent studying with a productive choice about learning in relation to time spent on web quest, with a total time on web quest = 100.00%.

Table 11. Number of learners consuming tea per web quest.

	Comparison group			Experimental group		
	WQ 1	WQ 2	WQ 3	WQ 1	WQ 2	WQ 3
Self-handicapping tea	2	3	4	4	1	2
Neutral tea	5	2	5	3	0	2
Focus tea	5	7	4	8	6	1

Note. WQ 1 = first web quest (i.e., Spanish theatre), WQ 2 = second web quest (i.e., Yeri language), WQ 3 = third web quest (i.e., open-ocean polynya); Comparison group: n = 34, Experimental group: n = 34.

Stepwise logistic regression was used to examine the extent to which claimed self-handicapping and interactions with the self-handicapping panel predict learners' affiliation with the comparison versus experimental group. A stepwise method was

chosen to automate selection of the 15 included predictor variables per web quest, 45 overall. Because these predictor variables are likely contributing differently to explaining learners' group affiliation, a combined forward and backward selection with AIC as metric was used. Stepwise logistic regression analyses were conducted with the predictor variables being interactions with each choice in the self-handicapping panel and claimed self-handicapping, each per web quest. None of these variables statistically indicated learners' group affiliation.

Multiple *t* tests adjusted for multiple testing were calculated to examine the extent to which learners in the comparison and experimental groups differed in number of claimed handicaps and interactions with the self-handicapping panel using the 15 variables identified earlier for each of the web quests. None of these analyses to describe differences in claimed self-handicapping or interactions with the self-handicapping panel between the comparison and the experimental group was statistically detectable.

4.5. How do Learners Self-handicap when Multiple Self-handicapping, Neutral, and Productive Approaches to Studying are Offered?

Cluster analysis was used to describe patterns of learners' choices in the self-handicapping panel to address the research question about how learners self-handicap when multiple self-handicapping, neutral, and productive approaches to studying are offered. More specifically, learners' interactions with the panel, personal ratings of choices offered in the panel, and claimed handicaps were examined. Because the method used for cluster analysis influences assignment of learners to clusters and the cluster solution, three methods for cluster analysis were considered: hierarchical agglomerative clustering, hierarchical divisive clustering and k-means clustering. Hierarchical agglomerative clustering begins with *n* clusters and continues by consecutively fusing similar clusters until all observations are subsumed in one cluster. Divisive hierarchical clustering instead begins with one cluster subsuming all observations and partitions observations into clusters. *k*-means clustering groups observations into the cluster of most similar observations, i.e., the cluster with the closest mean (Kaufman & Rousseeuw, 2009). *k*-means clustering appears to identify clusters of similar observations and having the greatest between-cluster distance. In

other words, this method most clearly identifies patterns of learners' ratings and choices about studying and their study environment. Thus, *k*-means cluster analysis was conducted.

To estimate the optimal number of clusters *k* in *k*-means clustering the elbow and average silhouette method were used. The elbow method explores within-cluster variation to determine the optimal value for *k*. The results shown in Figure 3 did not indicate a clear number of clusters as no obvious elbow is visible.

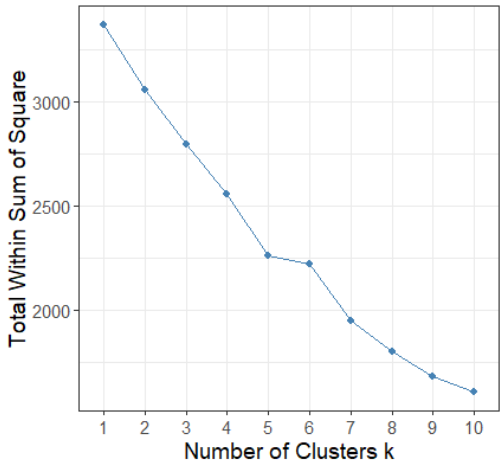

Figure 3. Optimal umber of clusters k estimated by the elbow method.

The average silhouette method focuses on the fit of each observation to a cluster. It suggests *k* = 2 is the optimal number of clusters (see Figure 4). Thus, k-means was conducted with the number of clusters *k* = 2. One learner was excluded from the analysis due to missing values. Cluster one comprised seven learners, 3 of whom were in the experimental group. Sixty learners were part of cluster two, 30 of whom were in the experimental group.

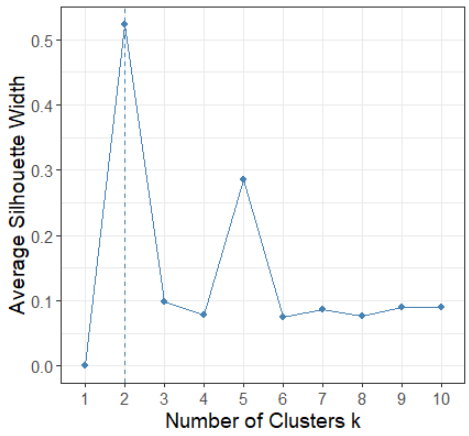

Figure 4. Optimal number of clusters k estimated by the average silhouette method

To visualize the two-cluster solution in a two-dimensional plot (see Figure 5), a principal components analysis was conducted. This method reduces the dimensionality in data to uncover patterns. A visualization of the two cluster solution in Figure 5 reveals clusters' centroids were widely separated on dimension one (horizontal separation). Except for two outlying cases in cluster one and very few cases in cluster 2, there was much less variation (vertical separation) on dimension two. Dimension one most clearly describes differences between the clusters. Figure 6 displays within-cluster means and standard deviations of variables listed in descending order of importance (loading) on principal component one.

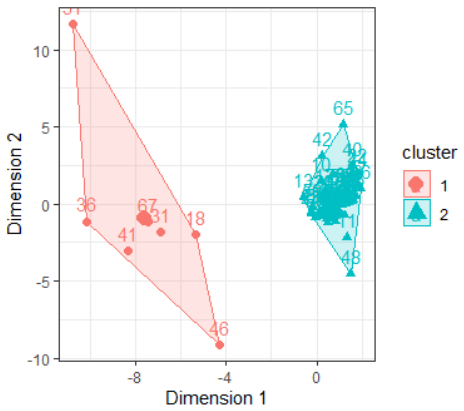

Figure 5. Visualization of the two-cluster solution.

Focusing on the most important variables listed in the upper five rows of Figure 6, it appears that learners in cluster one tend to spend less time using productive (i.e.,

focus) strategies than learners in cluster two while choosing to spend more time working on the web quests with neutral or self-handicapping options. Results displayed in this figure also suggest learners in cluster one claim fewer handicaps than learners in cluster two and rate most strategies in the self-handicapping panel as less efficient than learners in cluster two. Marking text by highlighting or tagging were the only two strategies that appear to be rated more favorably by learners in cluster one compared to their counterparts. Overall, it appears learners in cluster one are blatantly self-handicapping by selecting self-handicapping features while learners in cluster two handicap less conspicuously by claiming instead of choosing behavioral handicaps from the panel and selecting productive approaches to studying.

Welch's *t* test adjusted for multiple testing was used to analyze mean differences between cluster one and cluster two learners with respect to how they engaged with the self-handicapping panel, claimed handicaps, and rated choices in the self-handicapping panel. Visual inspection of the data indicated Welch's *t* test was appropriate. Cohen's *d* was used to quantify effect sizes for statistically detectable mean differences. According to Cohen (1992) values of $.20 \leq d \leq .50$ are considered small effects, $.50 \leq d \leq .80$ are medium effects, and values of $d > .80$ are classified as large effects. Learners in cluster one differed in time spent working on all of the three web quests with reduced or infrequently appearing ads (Table 12). The effect sizes are large (Cohen, 1992). Compared to learners in cluster two, learners in cluster one spent less time working on the three web quests with reduced frequency of popup ads and more time with the default setting of infrequently popping up ads (see Table 13). Learners in cluster one rated highlighting as a more effective strategy than learners in cluster two. Learners in the two clusters differed with medium effect size; $M_{Cluster1} = 0.512$, $M_{Cluster2} = -0.060$].

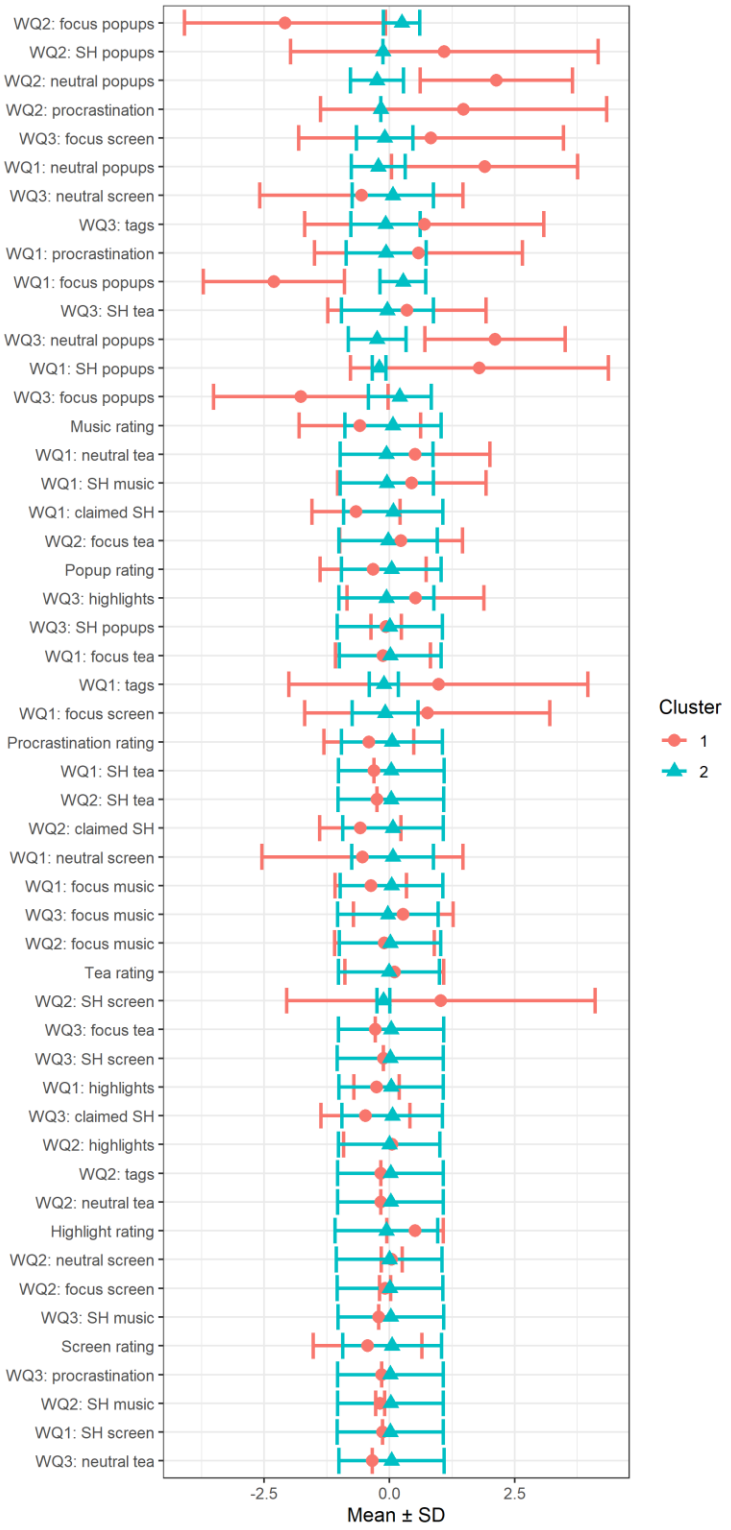

Figure 6. **Standardized means and standard deviations of the two clusters. Variables are listed in descending order of importance on dimension one as indicated by principal component analysis. SH = self-handicapping, WQ1 = web quest one, WQ2 = web quest two, WQ3 = web quest three.**

Table 12. Statistically detectable mean differences of engagement with the self-handicapping panel and strategy rating of learners in cluster one versus cluster two.

	DF	*t*	$p_{adjusted}$	Cohen's *d*	$CI_{Cohen's\ d}$
WQ1: focus popups	6.149	-4.815	.003	-4.219	-5.299, -3.139
WQ1: neutral popups	6.118	3.009	.023	3.488	2.489, 4.487
WQ1: SH tea	59.000	2.560	.013	0.347	-0.453, 1.147
WQ2: focus popups	6.046	-3.059	.022	2.783	1.853, 3.751
WQ2: neutral popups	6.170	4.117	.006	-2.465	-3.369, -1.561
WQ2: SH tea	59.000	2.053	.045	0.278	-0.521, 1.077
WQ3: focus popups	6.184	-2.973	.024	3.387	2.398, 4.376
WQ3: neutral popups	6.239	4.402	.004	-3.314	-4.295, -2.332
WQ3: focus tea	59.000	2.316	.024	0.314	-0.486, 1.113
WQ3: neutral tea	59.000	2.792	.007	0.378	-0.422, 1.179
Highlight rating	11.317	2.274	.043	0.576	-0.227, 1.389

Note. WQ1 = first web quest (i.e., Spanish theatre), WQ2 = second web quest (i.e., Yeri language), WQ3 = third web quest (i.e., open-ocean polynya), p-values are BH adjusted (Benjamini & Hochberg, 1995).

Small but statistically detectable differences in learners' choices about tea describe learners in cluster two as more reluctant to drink tea than their peers. Learners in cluster two chose to drink tea described as interfering with studying in the first web quest ($M_{cluster1}$ = -0.311, $M_{cluster2}$ = 2.56), while learners in cluster two selected self-handicapping tea more often in the second web quest ($M_{cluster1}$ = 0.029, $M_{cluster2}$ = -0.250). In the third web quest about open ocean polynya, learners in cluster one chose to drink neutral and focus tea more often than their peers in cluster two; neutral tea: $M_{cluster1}$ = 0.040, $M_{cluster2}$ = -0.339, focus tea: $M_{cluster1}$ = 0.033, $M_{cluster2}$ = -0.282.

Table 13. Standardized means of the time learners choose to work with reduced or infrequent popup ads.

	Focus popup frequency			Neutral popup frequency		
	WQ 1	WQ 2	WQ 3	WQ 1	WQ 2	WQ 3
Mean in cluster 1	- 2.310	-2.084	-1.766	1.900	2.135	2.106
Mean in cluster 2	0.269	0.243	0.206	-0.222	-0.249	-0.246

4.6. How do learners' choices about the study environment and study strategies change across task iterations?

Investigating the previous research question about patterns of learners' choices in the self-handicapping panel shed light on learners' preferences of choices within web quests. The focus of the following analyses are changes across web quests. Two approaches were used to examine the research question about how learners' choices change across task iterations, particularly shifts towards self-handicapping versus self-regulated learning approaches to studying. First, learners general use of the self-handicapping panel was analyzed using cluster analysis to identify how patterns of learners' choices reflect specific web quests. The purpose of this analysis is to examine if general use of the panel increases or decreases across task iterations and if selections of productive versus self-handicapping features are associated with earlier or latter web quests. Second, patterns describing changes from productive to counterproductive approaches to studying and vice versa were examined using decision tree analyses. Decision trees examine which choices in prior web quests led to a specific choice in the self-handicapping panel in a latter web quest, shedding light on possible shifts from productive to counterproductive choices and vice versa. These analyses were selected to investigate the extant to which patterns in the data reflect task iterations (cluster analysis) and describe how learners' decisions were formed across task iterations (decision tree analysis).

Patterns of learners' general use of the self-handicapping panel were explored using cluster analysis in terms of variables reflecting the 14 choices available in the self-handicapping panel: (1) highlights, (2) tags, (3) procrastination, (4) self-handicapping music, (5) focus music as well as self-handicapping, neutral and focus options for popup ads (6-8), screen brightness (9-11), and the kind of tea (12–14). The input data are learners by web quest. One learners' data for the first web quest was excluded from the analysis due to a missing value in this web quest, n = 203. As before k-means, hierarchical divisive, and hierarchical agglomerative clustering were calculated. The method that distinguished most clearly between clusters was k-means clustering.

As seen in Figure 7, the elbow method does not identify an obvious recommendation for number of clusters whereas the average silhouette method

indicates three is a relatively optimal number of clusters. Accordingly, three clusters were used for the following analyses. The three-cluster solution is illustrated in Figure 8.

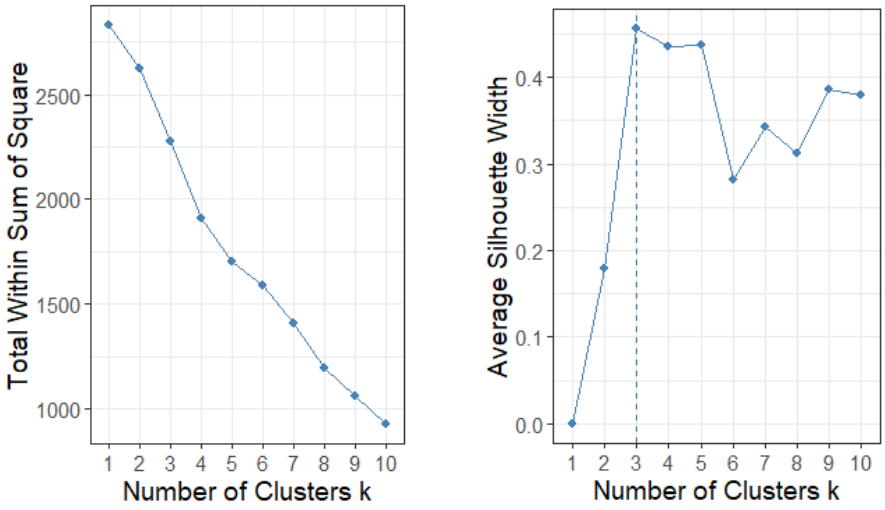

Figure 7. **The optimal number of clusters k indicated by the elbow method (i.e., figure on the left) and -average silhouette method (i.e., figure on the right).**

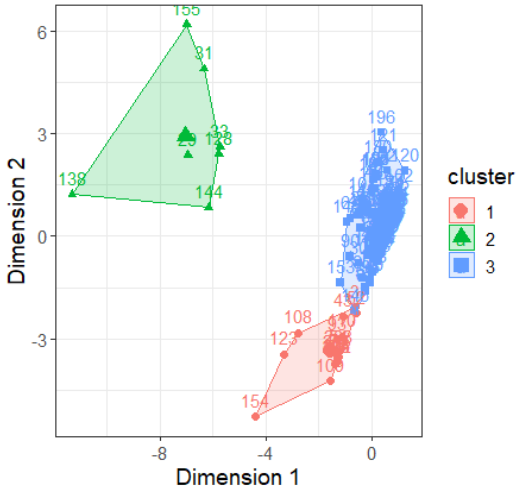

Figure 8. **Visualization of the three cluster solution. Observations represent each learner's engagement with features in the self-handicapping panel for each of three web quests.**

Learners by web quest were unevenly distributed across the three clusters in which each observation in a cluster represents one learner's engagement with one of the three web quests. Cluster one includes 18 observations, cluster two contains seven

observations and 178 observations are collected in cluster three. Figure 9 illustrates contrasts among the three clusters. Observations in cluster three appear to balance each other so the standardized cluster mean of observations centers around zero. This suggests moderate usage of each choice offered in the self-handicapping panel. On average, observations assigned to cluster two seem to signify self-handicapping practices to a greater extent than clusters one and three. More specifically, learners cluster two appears to drink more self-handicapping tea and spend more time listening to self-handicapping music. Observations in cluster two also emphasize preferences for changing the default (neutral) setting for screen brightness to a darker (focus) or brighter (self-handicapping) screen. Observations in cluster one indicate preferences for the default (neutral) setting of infrequently appearing advertising videos and a lower tendency to block these videos compared to the other clusters. Learners in cluster one also seem to listen less to self-handicapping music and drink less self-handicapping tea.

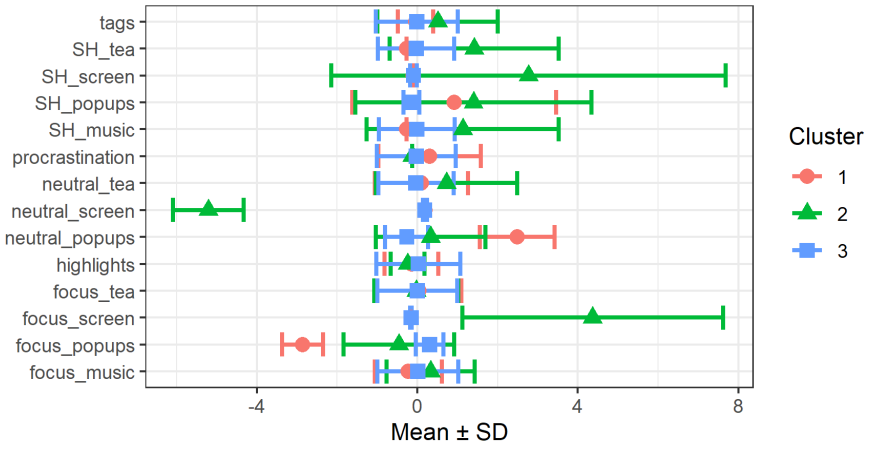

Figure 9. **Standardized means and standard deviations of the three clusters. Observations in the clusters represent each learner's engagement with features in the self-handicapping panel for each of three web quests. SH = self-handicapping.**

Differences between clusters were examined using linear mixed effects models. Models with a fixed effect for cluster assignment and a random intercept for each learner were estimated for each choice available in the self-handicapping panel. Given dependencies in the data due to repeated observations for each learner across the three web quests, mixed effects models are appropriate. Statistically detectable results for choices offered in the self-handicapping panel that differed across the three clusters are reported in Table 14.

Table 14. Results of linear mixed effects models for statistically detectable differences in general use of the self-handicapping panel between the three clusters.

	Cluster	β	*SE*	CI
SH tea	1 vs. 2	-1.615	0.423	-2.448, -0.783
	2 vs. 3	-1.377	0.351	-2.070, -0.686
SH screen	1 vs. 2	-2.877	0.379	-3.622, -2.132
	2 vs. 3	-2.868	0.327	-3.512, -2.223
SH Popups	1 vs. 3	-1.068	0.226	-1.512, -0.623
	2 vs. 3	1.545	0.352	-2.238, -0.852
SH music	1 vs. 2	-1.127	0.439	-2.017, -0.234
	2 vs. 3	-0.882	0.371	-1.646, -0.123
Neutral screen	1 vs. 2	5.399	0.071	5.295, 5.538
	2 vs. 3	5.397	0.061	5.276, 5.518
Neutral popups	1 vs. 2	2.114	0.279	-1.036, -0.102
	1 vs. 3	-2.683	0.162	-3.009, -2.344
	2 vs. 3	-0.569	0.237	-1.036, -0.109
Focus screen	1 vs. 2	-4.527	0.249	-5.018, -4.036
	2 vs. 3	-4.526	0.216	-4.950, -4.101
Focus popups	1 vs. 2	-2.358	0.192	-2.740, -1.974
	1 vs. 3	3.146	0.110	2.924, 3.363
	2 vs. 3	0.788	0.164	0.463, 1.112
Focus music	1 vs. 2	-0.830	0.349	-1.517, -0.139
	1 vs. 3	0.507	0.237	0.037, 0.977

Note. SH = self-handicapping, focus = productive choice; Confidence intervals excluding zero indicate statistically detectable differences between clusters.

Standardized means and standard deviations are presented in Table 15. Cluster two represents the most active use of features in the self-handicapping panel, particularly self-handicapping and focus screen settings and listening to music. Cluster one seems to reflect less active use of the self-handicapping panel. In this cluster the default settings of neutral screen brightness was not changed. However, this cluster tolerates infrequently to frequently appearing advertising videos (i.e., neutral and self-handicapping popup advertisement settings). Cluster three describes the majority of observations and highlights preference for reducing or blocking popup ads. Means of observations in cluster three show a slight tendency toward productive rather than

counterproductive choices in the self-handicapping panel. The three clusters included observations from all three web quests, emphasizing patterns in learners' general use of the self-handicapping panel does not change across task iterations.

Table 15. Standardized means and standard deviations of statistically detectable differences in general use of the self-handicapping panel between clusters.

	Cluster 1		Cluster 2		Cluster 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
SH tea	-0.271	0.001	1.416	2.104	-0.028	0.951
SH screen	-0.107	0.001	2.769	4.921	-0.098	0.079
SH popups	0.920	2.544	1.397	2.946	-0.148	0.201
SH music	-0.270	0.001	1.131	2.393	-0.017	0.943
Neutral screen	0.188	0.010	-5.211	0.878	0.186	0.053
Neutral popups	2.491	0.931	0.325	1.367	-0.265	0.538
Focus screen	-0.157	0.006	4.370	3.253	-0.156	0.020
Focus popups	-2.858	0.513	-0.461	1.383	0.307	0.342
Focus music	-0.225	0.834	0.334	1.097	0.010	1.012

Note. SH = self-handicapping.

Choices learners made across the three web quests of the 14 possible choices in the self-handicapping panel and their claimed handicaps were explored further using decision trees, specifically conditional inference trees. Conditional inference trees investigate which previous choices can explain a latter choice. Because each choice is classified as either a productive, neutral, or counterproductive approach to learning, shifts from productive to counterproductive approaches across web quests and vice versa can be observed. This stepwise non-parametric method is appropriate for data with an inflated frequency of zero scores. In this study, zeros represent learners' absence of choices in the self-handicapping panel. At each step in the analysis, the value of a predictor variable is sought that partitions the response variable into two groups that are most statistically significantly different (for details on this method, see Hothorn et al., 2006; Hothorn & Zeileis, 2015), At the final step, the response variable has been partitioned into the greatest number of terminal nodes based on non-overlapping regions for values of the predictor variable(s). Nodes are points of decisions where the response variable is partitioned.

Multiple decision tree analyses explored each choice learners could make in the self-handicapping panel during the second web quest and during the third web quest as a response variable in a separate decision tree. Predictors were the 14 possible choices in the self-handicapping panel in any prior web quest, claimed handicaps in any prior web quest, and learners' personal rating of choices offered in the self-handicapping panel. Decision trees identify which predictor variables can explain the response variable. These analyses shed light on how learners formed decisions to self-handicap in a particular web quest based on data describing their experience with self-handicapping as reflected by choices selected in the self-handicapping panel, claims about self-handicapping, and personal ratings of features in the self-handicapping panel.

Learners' claimed handicaps for a web quest can be explained by handicaps claimed in the immediately prior web quest. The decision tree in Figure 10 describes how learners formed decision to claim handicaps prior to web quest two. Decision trees are displayed upside down. This means, the first node created (labeled "1" in Figure 10) is the root of the decision tree and is displayed at the top of the figure. Terminal nodes displayed at the bottom (labelled "node 3", "node 4", and "node 5" in Figure 10) are categories of the response variable for groups of learners who followed different paths in the decision tree.

In Figure 10, the response variable is claimed self-handicapping score prior to web quest two and it was dependent on claimed self-handicapping prior to web quest one. Learners' scores on this input variable were differentiated by the decision tree analysis to create three terminal nodes, node 3, node 4, and node 5, which originated in nodes 1 and 2. In this particular case node 2 is a further specification of node 1, i.e., scores ≤ 51 are further decomposed into scores between 0 and 32, and scores between 33 and 51. The box and whisker plots displayed for terminal nodes at the bottom of Figure 10 visualize medians of the response variable for groups of learners described by different paths in the decision tree. For example, the twenty-five learners in node 3 had a score ≤ 32 on the claimed self-handicapping questionnaire prior to web quest one. These learners' median score was 22 on the claimed self-handicapping questionnaire prior to web quest two. This box and whisker plot also indicates scores on the claimed self-handicapping questionnaire prior to web quest two ranged mainly between 14 and 31 with one outlier whose score was 75. The thirty-three learners with scores greater than 51 prior to web quest one (node 5) had scores ranging from 35 to 100 with a

median score of 59 prior to web quest two. Learners in node 4 (n = 10) who had a score between 33 and 51 prior to web quest one, scored on average 38, with scores ranging from 21 to 52 prior to web quest two on the claimed self-handicapping questionnaire.

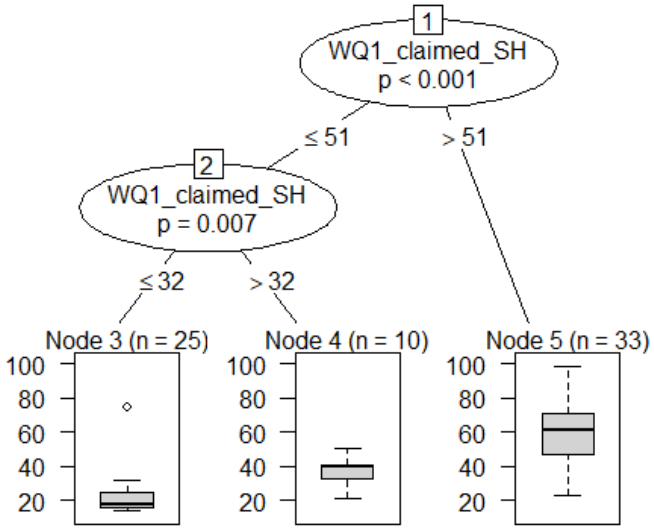

Figure 10. Decision tree explaining learners' scores on claimed self-handicapping prior to web quest two (response variable) with scores on claimed self-handicapping prior to web quest one (input variable). Box and whisker plots visualize values of the response variable.

Learners' decisions to claim handicaps prior to web quest three are visualized in Figure 11. This decision tree is partitioned into 3 inner and 4 terminal nodes. Scores on claimed self-handicapping prior to web quest two (input variable) can differentiate scores prior to web quest three. The four terminal nodes describe groups of learners scoring from low to high on claimed self-handicapping prior to web quest three. For example, fourteen learners scored ≤ 19 on claimed self-handicapping prior to web quest two (node 4) and scored between 12 and 20 prior to web quest three, Md_{WQ3} = 16. The twenty-five learners who scored > 50 on claimed self-handicapping prior to web quest two (node 7), had scores ranging from 40 to 72 with a median score of 64 prior to web quest three.

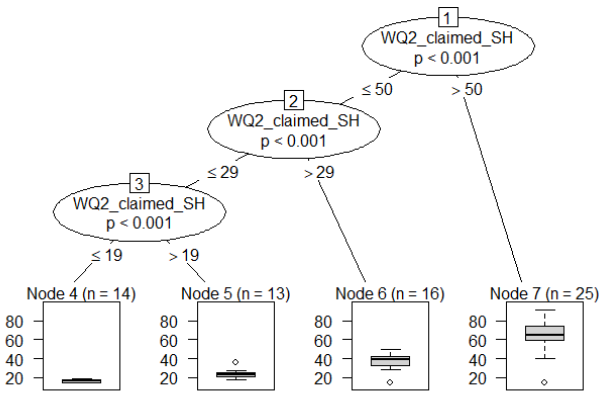

Figure 11. Decision tree explaining learners' scores on claimed self-handicapping prior to web quest three (response variable) with scores on claimed self-handicapping prior to web quest two (input variable). Box and whisker plots visualize values of the response variable.

The two decision trees about claimed self-handicapping illustrated in Figure 10 and Figure 11 suggest scores of claimed handicaps prior to web quest one explain scores of claimed handicaps prior to web quest two, which in turn explain score on the same questionnaire completed prior to web quest three. Learners scoring greater than 51 prior to web quest one also scored high prior to web quest two and web quest three, and learners scoring low prior to web quest one, scored low on all web quests. This indicates that learners' choices to claim handicaps are similar across task iterations.

Some of learners' decisions to choose a feature in the self-handicapping panel were explained by choosing the same feature in a previous web quest. Decisions to select a feature in web quest two that was explained by choosing the same feature in web quest one were decisions to create highlights, listen to focus music, and maintain the default frequency of popup ads, i.e., neutral popups. In the third web quest these variables were listening to distracting and focus music, and reducing the frequency of popup ads, i.e., focus popups. The decision to listen to focus music while working on web quest three is visualized in Figure 12. Learners listening to focus music less than or equal to 4.4% of their time spent on web quest one, on average listened to focus music for 4.1% of their time spent on web quest three (node 2). Nineteen of the learners who listened for more then 4.4% of their time spent on web quest one and more than 48.8% of time spent on web quest two, spent on average 84.1% of their time on web quest three listening to focus music (node 5). These choices emphasize learners' preferences

for specific features in the self-handicapping panel. Decision trees for the aforementioned choices are visualized in Appendix B.

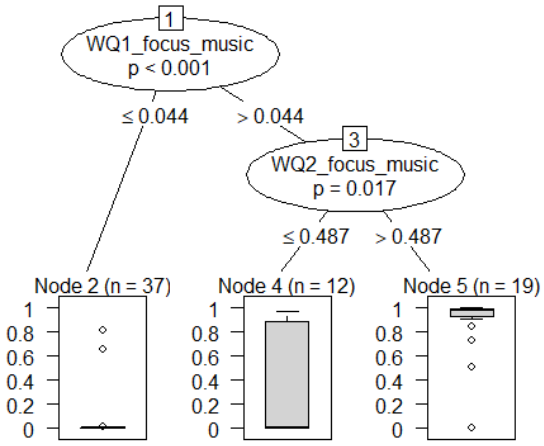

Figure 12. Decision tree explaining learners' choice to listen to focus music in web quest three (response variable) by percentage of time on web quest one and two listened to focus music (input variables). Box and whisker plots visualize values of the response variable.

For five response variables the mean was a better predictor than decision trees including any of the possible predictor variables. These response variables are tags in the second and third web quest, as well as neutral or focus settings of screen brightness, and self-handicapping tea selection in the third web quest.

The following decision trees support the self-handicapping hypothesis that learners make self-handicapping rather than productive or neutral choices in the self-handicapping panel over time. This includes patterns of choices shifting from productive or neutral choices in the first web quest to self-handicapping choices in the subsequent web quest(s) as well as decisions to increase the intensity of self-handicapping choices or reducing the intensity of productive choices about learning. For example, learners who made the productive choice of creating highlights in the first web quest then chose to drink self-handicapping tea in subsequent web quests. Some of these decision trees also emphasize learners' preferences for specific features in the self-handicapping panel. For example, learners who made the productive choice to darken screen brightness in the first web quest then chose the self-handicapping setting for screen brightness in a subsequent web quest.

The set of decision trees are described in Table 16. For example, the time learners spent procrastinating in web quest three is accounted for by the time learners listened to self-handicapping music in web quest two. The 61 learners who listened to self-handicapping music less than 0.5% of their time on web quest two spent on average 0.1% of their time on web quest three procrastinating. In contrast, the seven learners who listened to self-handicapping music for more than 0.5% of their time on web quest two, procrastinated on average 2.4% of their time on web quest three. These results highlight learners repeatedly chose to self-handicap over time.

Table 16. Learners decisions indicating self-handicapping over task iterations.

Response variable	$M_{Response}$	n	Decision tree node
WQ 3: procrastination	0.001	61	If WQ 2: SH music ≤ 0.005
	0.024	7*	If WQ 2: SH music > 0.005
WQ 2: SH popups	0.006	7	If WQ 1: neutral popups ≤ 0.347 and WQ 1: neutral screen ≤ 0.997
	0.000	53	If WQ 1: neutral popups ≤ 0.347 and WQ 1: neutral screen > 0.997
	0.142	7*	If WQ 1: neutral popups > 0.347
WQ 2: SH music	0.019	61	If WQ 1: SH screen ≤ 0.001
	0.135	7*	If WQ 1 SH screen > 0.001
WQ 2: procrastination	0.000	54	If WQ 1: SH popups ≤ 0.001 and WQ 1: neutral popups ≤ 0.329
	0.006	7*	If WQ 1: SH popups ≤ 0.001 and WQ 1: neutral popups > 0.329
	0.009	7*	If WQ 1: SH popups > 0.001
WQ 2: SH screen	0.000	61	If WQ 1: focus screen ≤ 0.001
	0.005	7*	If WQ 1: focus screen > 0.001
WQ 3: SH screen	0.000	61	If WQ 1: focus screen ≤ 0.002
	0.141	7*	If WQ 1: focus screen > 0.002
WQ 2: SH tea	0.033	61	If WQ 1: highlights ≤ 8
	0.286	7*	If WQ 1: highlights > 8

Note. WQ 1 = first web quest (i.e., Spanish theatre), WQ 2 = second web quest (i.e., Yeri language), WQ 3 = third web quest (i.e., open ocean polynya), SH = self-handicapping, $M_{Response}$ is the mean of the response variable in percentage (i.e., time spent with the response variable in relation to time on a web quest) with 1 = 100%. Highlights and tea are reported as the number of highlights created or cups of tea consumed, * = decision nodes supporting the self-handicapping hypothesis.

Decision trees supporting the opposing hypothesis, that learners productively self-regulate learning by choices about studying over task iterations are described in Table 17. These decisions describe a shift from self-handicapping to neutral or productive approaches to studying as well as shifts from a neutral to a productive choice. For example, learners who listened to self-handicapping music for more than 26.6% of their time spent on the first web quest (n = 7) made the productive choice of working with a darker screen for about 14.5% of the time spent on web quest two. These patterns of productive choices over time mainly appeared from web quest one to web quest two. Only one decision tree later in the sequence describes a shift from listening to self-handicapping music in web quest two to drinking neutral tea in web quest three. As before, some decision trees or nodes highlight learners' preferences for specific strategies or features in the self-handicapping panel. For example, learners who created more than six highlights in web quest one created eight highlights on average in web quest two.

Overall, decision tree analyses emphasize learners' preferences for specific strategies or features in the self-handicapping panel. Two approaches to studying over time were revealed: self-handicapping versus self-regulated learning approaches. These decision nodes (marked with an asterisk in Table 16 and Table 17 were further inspected on the level of individual learners to enhance understanding about their self-handicapping versus productive self-regulated learning choices over time.

Ten learners chose a self-handicapping approach to studying across task iterations. Decision nodes and means of the response variable are reported in Table 18 for those learners who unambiguously chose self-handicapping approaches to studying over time. For example, a learner chose to study with infrequently appearing advertising videos in web quest one and increased the frequency of popup ads while also procrastinating on web quest two.

Two learners chose more ambiguous approaches regarding self-handicapping by selecting both productive and counterproductive approaches to studying at first but shifting to a counterproductive approach in the subsequent web quest. One of these learners shifted from listening to self-handicapping music and darkening the screen brightness (i.e., focus screen) in web quest one to creating highlights and trying out the three settings for screen brightness in web quest two. In web quest three, this learner

decided to study with a brighter screen which was presented as hindering studying. The other learner shifted from working with a neutral and brighter screen (i.e., neutral and self-handicapping screen) in web quest one to listening to self-handicapping music, working with a brighter screen, and drinking neutral tea in web quest two. In the third web quest, this learner chose to self-handicap by increasing the screen brightness. While the changes from web quest one to web quest two are both productive and counterproductive approaches to studying, in web quest three the learner self-handicaps by increasing the screen brightness.

Table 17. Learners' decisions indicating choices to productively self-regulate learning across task iterations.

Response variable	$M_{Response}$	N	Decision tree nodes
WQ 2: focus screen	0.000	61	If WQ 1: SH music ≤ 0.265
	0.145	7*	If WQ 1: SH music > 0.265
WQ 2: neutral screen	1.000	54	If WQ 1: SH music ≤ 0.265 and WQ 1: SH popups ≤ 0
	0.999	7*	If WQ 1: SH music ≤ 0.265 and WQ 1: SH popups > 0
	0.850	7*	If WQ 1: SH music > 0.285
WQ 2: neutral tea	0.016	61	If WQ 1: SH screen ≤ 0.001
	0.143	7*	If WQ 1: SH screen > 0.001
WQ 3: neutral tea	0.006	61	If WQ 2: SH music ≤ 0.005
	0.429	7*	If WQ 2: SH music > 0.005
WQ 2: highlights	1	50	If WQ 1: highlights ≤ 6 and WQ 1: SH music ≤ 0.265
	4	7*	If WQ 1: highlights ≤ 6 and WQ 1: SH music > 0.265
	8	11*	If WQ 1: highlights > 6
WQ 2: focus popups	0.517	7	If WQ 1: focus popups ≤ 0.420
	0.921	54	If WQ 1: focus popups > 0.420 and WQ 1: neutral popups ≤ 0.212
	0.789	7*	If WQ 1: focus popups > 0.420 and WQ 1: neutral popups > 0.212

Note. WQ 1 = first web quest (i.e., Spanish theatre), WQ 2 = second web quest (i.e., Yeri language), WQ 3 = third web quest (i.e., open ocean polynya), SH = self-handicapping, $M_{Response}$ = mean of the response variable in percentage (i.e., time spent with the response variable in relation to time on a web quest) with 1 = 100%. Highlights and tea are reported as the number of highlights created or cups of tea consumed, * = decision nodes supporting the self-regulated learning hypothesis.

Table 18. Individual learners' decision nodes indicating self-handicapping choices across task iterations.

Decision node	$M_{Response}$	Individual learners							
If WQ 1: neutral popups > 0.347	WQ 2: SH popups = 0.142				X				X
If WQ 1 SH screen > 0.001	WQ 2: SH music = 0.135			X				X	
If WQ 1: SH popups ≤ 0.001 and WQ 1: neutral popups > 0.329	WQ 2: procras-tination = 0.006								X
If WQ 1: SH popups > 0.001	WQ 2: procras-tination = 0.009				X				
If WQ 1: focus screen > 0.001	WQ 2: SH screen = 0.005	X				X	X	X	X
If WQ 1: highlights > 8	WQ 2: SH tea = 0.286		X						
If WQ 2: SH music > 0.005	WQ 3: procras-tination = 0.024		X						
If WQ 1: focus screen > 0.002	*WQ 3: SH screen = 0.141*					*X*	*X*	*X*	*X*

Note. WQ1 = web quest one (i.e., Spanish theatre), WQ2 = web quest two (i.e., Yeri language), WQ 3 = web quest three (i.e., open-ocean polynya), SH = self-handicapping.

The majority of learners (n = 25) made choices described by decision tree analysis as indicating self-handicapping or self-regulated learning choices over time. These learners pursued productive and counterproductive approaches to learning across web quests. For example, a learner studied while allowing advertising videos to infrequently popup in web quest one and made the productive choice to reduce or block popup ads but also chose to procrastinate on web quest two.

Nine of the twelve learners' choices indicating self-regulated learning over task iterations were described by a single decision node. For example, two learners reduced the frequency of popup ads from web quest one to web quest two. Choices of three learners were captured in multiple decision nodes, describing a change from self-handicapping to more productive approaches to studying. Two of these learners changed from listening to self-handicapping music in web quest one to creating highlights and switching between neutral and focus settings of screen brightness. The other learner made the same choices but also changed from listening to self-

handicapping music in web quest two to drinking neutral tea in web quest three. These decision nodes are reported in Table 19.

Table 19. Individual learners' decision nodes indicating productive self-regulated learning choices across task iterations.

Decision node	$M_{Response}$	Individual learners					
f WQ 1: focus popups > 0.420 and WQ 1: neutral popups > 0.212	WQ 2: focus popups = 0.789	X^2					
If WQ 1: SH screen > 0.001	WQ 2: neutral tea = 0.143			X			X
If WQ 2: SH music > 0.005	WQ 3: neutral tea = 0.429						X
If WQ 1: SH music ≤ 0.265 and WQ 1: SH popups > 0	WQ 2 neutral screen = 0.999				X		
If WQ 1: SH music > 0.285	WQ 2 neutral screen = 0.850					X	X	X
If WQ 1: SH music > 0.265	WQ 2: focus screen = 0.145					X	X	X
If WQ 1: highlights ≤ 6 and WQ 1: SH music > 0.265	WQ 2: highlights = 4		X^5			X	X	X

Note. WQ1 = web quest one (i.e., Spanish theatre), WQ2 = web quest two (i.e., Yeri language), WQ 3 = web quest three (i.e., open-ocean polynya), SH = self-handicapping; X^2 = two individual learners who made the same choice; X^5 = five individual learners who made the same choice.

Inspecting decision nodes on an individual learner level supports the previous observation that some learners choose self-handicapping approaches to studying while others self-regulate learning over time and make more productive choices across task iterations. Over time, self-handicappers appear to make multiple shifts from productive and neutral ways of learning to self-handicapping approaches, while the majority of self-regulated learners made only one shift towards productive approaches to studying. In contrast to expectations, self-handicappers were mainly in the comparison group (n_{EG} = 3, n_{CG} = 7) while self-regulated learners were predominantly in the experimental group (n_{EG} = 8, n_{CG} = 4). Most of the learners chose a mix of productive and counterproductive approaches to studying across task iterations.

Chapter 5. Discussion

In the self-handicapping literature, research examining learning activities is scarce and data about learning activities were primarily self-reports. As previously reviewed, self-report data may not provide grounds for valid inferences about how learners behave. Research adopting an experimental paradigm sparked concerns about ecological validity and generalizability of findings because tasks used, and choices offered to learners were poor approximations to authentic learning situations. In contrast, the current research makes novel contributions to the field. Learners engaged in a task common to higher education and were offered multiple occasions to choose among multiple relatively authentic self-handicapping, neutral, and productive approaches to learning.

Building on self-handicapping research so far, I developed and psychometrically analyzed a behavioral measure of self-handicapping, i.e., the self-handicapping panel that traces learners' self-handicapping, neutral, and productive choices about learning. Learners' self-handicapping choices were examined a) to compare learners receiving contingent versus non-contingent success feedback, b) in relation to neutral and productive choices about learning, and c) across task iterations. Self-handicapping was traced over task iterations to provide opportunity to examine how learners' choices to self-handicap change over time. This offers novel insights into metacognitive processes involved in learners' choices to self-handicap. Additionally, this research yields much more fine-grained data on self-handicapping gathered unobtrusively across the course of multiple learning tasks.

5.1. How Valid are Interpretations of the Behavioral Measure of Self-handicapping?

Contrary to expectations, learners' choices for self-handicapping behavior offered in the self-handicapping panel were not associated with self-reported self-handicapping. Inferences about convergence representing the construct could not be supported. It is unclear whether this reflects a discrepancy between constructs measured or methodological variance (Campbell & Fiske, 1959).

The choice of a method for measurement, self-report versus trace matters. In self-reports, learners are asked to draw on their experience or imagine a specific context while answering questions. A pitfall here is the inability to distinguish behavioral (actual) from claimed self-handicapping which jeopardizes validity of interpretations (Schwinger et al., 2014; Török et al., 2018). Additionally, accuracy of self-reported data may be lessened, for example, by overconfidence whereas traces are direct indications of behavior thoroughly and precisely recorded when learners do what they do (Winne, 2020a, 2020b). For example, a self-report measure of behavioral self-handicapping asks learners to rate how true it is for them to "…sometimes put off doing my school work until the last minute so that if I don't do well on my work I can say that is the reason" (Midgley & Urdan, 1995; Urdan & Midgley, 2001). In this research, in contrast, learners could demonstrate procrastination while studying by clicking links to visit web pages to "take a break" even though this was described as "making studying more challenging." By not explicitly naming behavior as self-handicapping, traced self-handicapping behavior may be closer to learners' choices about self-handicapping while studying outside the laboratory. Researchers expressing concern about self-deception of self-handicappers, caution against trusting self-reported self-handicapping (Baumeister, 1996; Clarke & MacCann, 2016; McCrea, Hirt, Hendrix, et al., 2008; Rhodewalt & Vohs, 2005; Török et al., 2018). This may be alleviated by tracing rather than asking about self-handicapping. Given these considerably different approaches to examining behavioral self-handicapping it is plausible that the two measures are not statistically significantly associated.

Learners' choices in the self-handicapping panel were associated as expected with criteria for discriminant validity regarding self-reported impostor syndrome and traced highlighting precision. In this experiment, learners self-reported impostor feelings were moderately negatively associated with choices to spend time procrastinating on the first web quest task, and moderately positively correlated with the number of highlights created in the second web quest task. Traced highlighting precision was associated with choices to complete the third web quest task under the condition of infrequently appearing advertising videos. Time studying texts to complete the first web quest with the same setting of popup ads was associated with self-reported impostor feelings. However, neither highlighting precision nor the impostor syndrome explained much of the variance. These findings suggest validity of interpretations about learners' choices in

the self-handicapping panel but also signal a pitfall – statistical power to detect effects was reduced due to a high frequency of zero values in the data describing absence of choices in the self-handicapping panel. Selecting specific features in the panel often meant values were zero for other choices. For example, in web quest one, two, and three, only three, two, and two, learners procrastinated, respectively. It is reasonable to forecast that replicating this study with a larger sample size could yield sufficient statistical power to detect hypothesized relationships between choices in the self-handicapping panel and variables representing theoretical assumptions on how the construct of behavioral self-handicapping behaves.

Self-handicapping studies adopting experimental approaches done so far implemented three central components to enhance the likelihood of observing self-handicapping behavior: (a) uncertainty, mainly operationalized by non-contingent success feedback, (b) task relevance in a form where task failure entails a self-esteem threat, and (c) opportunity to self-handicap. Learners' thoughts about the experiment they shared during the thorough debriefing exemplify learners' perceptions of these components and suggest validity of interpretations of the behavioral measure.

Upon completion of the experiment, most learners sharing how they experienced feedback expressed surprise but belief that feedback was accurate. One learner described their thought process when receiving non-contingent success feedback as follows: "I was… debated with myself… can the feedback… can it be true?... Did I really do that well?... Maybe others… didn't do well… so I guess… I guess, I thought… yes… it [feedback] was [true]".

This learner explains how non-contingent success feedback elicited feelings of uncertainty because descriptions of performance in the feedback deviated from their expectations. After some internal debate, the learner reached the conclusion that feedback was credible. Another learner provided a similar description of experience of non-contingent success feedback but also emphasized pressure to maintain high performance:

> "I was surprised… didn't expect feedback at all… wasn't sure about some answers. To see the numbers that I did… was a little bit… like… surprising. It

was… for the most part was encouraging but… also like… a little bit like I am doing well so I have to keep this up … so it… it's like… it added pressure."

The learner described feedback as a source of motivation to achieve a high score on subsequent web quests. This is evidence for learners' acceptance of the context set for this study, namely, the description that performance on each web quest was a relatively accurate predictor for future success or failure in university studies. This elevated task relevance and increased the likelihood learners would perceive failure in the web quests as a threat to self-esteem, All learners in this study provided written responses indicating that they believed the described dependency between performance in web quests and academic studies. One learner said they were "terrified when submitting the web quests". Another learner emphasized how non-contingent success feedback on the web quest created uncertainty about their ability to succeed in their academic program:

"I couldn't find the answers. So… so I read… over and over… and couldn't believe it. That's why I took so long to do the… answers. I can't believe it… so glad… now that I know the questions were not there… and the feedback… isn't… is not how I did. Feel much better. I want to do humanities major… but… ehm started to question if that is... if it's a good idea… cause… I had such a hard time answering the questions".

Learners written responses for why they made choices in the self-handicapping panel offer strong evidence for learners' understanding about implications of choices in the panel. For example, one learner described that "the study focus music definitely helped me remain in the zone." Another learner reported blocking popup ads "because they made me lose focus of what I was reading." Some learners reported strategic selections of features in the self-handicapping panel to balance productive and counterproductive approaches to studying:

"I thought I would like the screen being darker, but in fact paired with the focus tea I found myself re-reading questions and getting bored, however when I drank the distracting tea I needed a brighter screen and found I got a burst of energy and pushed through that one quite quickly. (…) but I also turned off all of my pop-up ads so I wouldn't get distracted."

Other learners explained choices in the self-handicapping panel in relation to their study habits. Three learners explained they did not choose to procrastinate on pre-selected webpages because “I always lose track of time” or “I knew I would get distracted, as I do at home - one article leads to the next.”

Similarly, 32 of the 68 learners explained making choices characteristic of how they usually study, suggesting interpretations based on the self-handicapping panel have ecological validity. Two learners explained they usually listen to music while studying to block out distracting sounds and increase concentration. One learner offered this description for choices in the self-handicapping panel: “I chose to keep the screen dark, drank neutral tea with no music, and didn't highlight or tag. This is usually how I study (without the tea though).” Another learner reported having chosen to drink different kinds of tea during the web quests “because I also drink tea, and most of the time, coffee when studying.” Some learners explained they did not select certain features in the self-handicapping panel as this would not reflect how they usually study. For example, a learner reported they did not create highlights or tag information as these were not strategies they use while studying.

Even though learners’ written responses indicated they understood implications of specific features in the self-handicapping panel, it should be noted that, after experiencing these features while studying, some learners provided alternative descriptions. For example, two learners described how listening to self-handicapping music helped them maintain motivation and concentration to complete the web quests. Another learner indicated that creating highlights helped allocate main ideas in the texts but that they “stopped highlighting for web quest 3 because I was interested in the material and retained it more readily." Another learner explained: “Personally, I don't like highlighting or tagging as I read, because seeing different colors on a screen is more distracting to me." To explain why one learner did not drink tea during the web quests, they pointed out “asking for tea would require some interaction which might be distracting”.

Overall, evidence suggests validity of the measure of behavioral self-handicapping developed for this study. As always, further research is needed to provide stronger grounds for this assumption. I recommend particular focus on investigating associations with self-reported self-handicapping.

5.2. How do Choices in the Self-handicapping Panel differ among Learners Receiving Contingent versus Non-contingent Success Feedback?

Providing learners with non-contingent success feedback, i.e., feedback that does not reflect actual performance, creates uncertainty about ability to repeat the outcome in a similar task (e.g., Berglas & Jones, 1978; Kolditz & Arkin, 1982; Tucker et al., 1981). In this study, learners were provided with contingent (comparison group) or non-contingent success feedback (experimental group) to compare learners who are likely to self-handicap and those who are likely to choose neutral or productive approaches to learning.

Opposite to expectations, contingency of feedback was not statistically significantly associated with learners claimed or practiced behavioral self-handicapping. This finding contrasts other strong empirical evidence suggesting learners are more likely to choose counterproductive approaches to learning after receiving non-contingent success feedback (e.g., Deppe & Harackiewicz, 1996; Higgins & Harris, 1988; Rhodewalt & Davison, 1986). For example, in other studies, after receiving non-contingent success feedback, learners consumed more of a performance hindering beverage (Higgins & Harris, 1988) and listened to self-handicapping music more often (Rhodewalt & Davison, 1986) than learners receiving contingent success feedback.

In this study, learners receiving contingent success feedback appear to have engaged more actively with the self-handicapping panel than learners receiving non-contingent success feedback. Learners receiving contingent success feedback spent more time listening to self-handicapping music, studying with performance debilitating screen brightness, and consumed more neutral, focus, and self-handicapping tea, particularly in latter study activities. Learners receiving non-contingent success feedback, in contrast, created more highlights across study activities than their peers. Similar patterns were found when focusing on learners' productive versus counterproductive choices across study activities. The majority of learners who chose productive approaches to studying over time received non-contingent success feedback, while most of the learners receiving contingent success feedback made counterproductive choices about studying over time. For example, learners who listened to self-handicapping music in the first study activity also darkened the screen brightness

which was described as conducive to performance. In contrast, learners shifting from productive to counterproductive approaches to studying, for example, created highlights in the first study activity and consumed self-handicapping tea in the subsequent study activity. These group differences are in direct contrast to prior research and should be interpreted with caution as these observations were not statistically detectable.

In the thorough debriefing of learners upon completion of the experiment, five learners shared how they experienced feedback in this study. All of them explained feelings in line with receiving non-contingent success feedback. For example, one learner described experience in the web quests as follows: “I was wondering about that [feedback]. Because… It felt better than I did. I had doubts about myself… because… cause the answers… I couldn’t find it [answers]”.

Although four of the five learners expressing doubts about their ability to maintain success across study activities received non-contingent success feedback, the learner providing the aforementioned description was in the comparison group and received feedback that was presented to reflect actual performance on the web quest task. In contrast to the experimental group, texts available to the comparison group contained sufficient information to answer the web quests. Yet, this learner in the comparison group described contingent feedback as non-contingent. This learner experienced difficulties finding information in the texts to answer the questions and thus experienced the experiment similarly as learners in the experimental group. Perhaps learners who did not volunteer information about feedback had similar experiences, potentially clouding group comparisons.

Thompson and Richardson (2001) demonstrated learners receiving accurate performance feedback claimed more handicaps than learners receiving non-contingent feedback, but they were unable to replicate this result (Thompson, 2004). In the present study, learners claimed more handicaps after receiving contingent rather than non-contingent success feedback. While these group differences align to Thompson and Richardson’s (2001) findings, my results were not statistically detectable and should thus be interpreted with caution.

5.3. How do Learners Self-handicap when Multiple Self-handicapping, Neutral, and Productive Approaches to Studying are Offered?

In this study, learners were offered several self-handicapping, neutral, and productive choices about learning in the self-handicapping panel. The panel transmutes handicaps described in prior research into measures tracing learners' choices while studying. For example, instead of asking learners whether they would choose to listen to a high pitched noise (Kim et al., 2010), learners in this study could actually regulate the frequency of popup ads, a more authentic distracting noise while studying. Handicaps were described to learners as adversely affecting performance (e.g., listening to self-handicapping music) or benefitting performance (e.g., highlighting text). Patterns of learners' choices in the self-handicapping panel, their claims about self-handicapping, and personal ratings of choices offered describe learners' preferences for specific choices. Based on these decisions, learners were classified in two groups: blatant and hidden self-handicappers.

The seven learners who chose to self-handicap blatantly spent more time studying with infrequently appearing popup ads than their peers but chose fewer productive approaches to studying e.g., listening to focus music. They appeared to make more self-handicapping choices e.g., procrastinate, while claiming fewer handicaps. Behavioral self-handicapping appears to exceed claimed self-handicapping in this group. Self-handicapping choices in the self-handicapping panel were rated less negative and productive choices less favorable by this group, except for highlighting text, a strategy they appear to have used sparsely. These learners seemed to prefer drinking tea while studying, as they consumed more tea than their counterparties, particularly self-handicapping tea in web quest two and focus and neutral tea in web quest three. The 60 learners who self-handicapped more inconspicuously claimed more handicaps and chose to block distracting popup ads while studying more often than blatantly self-handicapping learners. However, in the first web quest, before receiving feedback, hidden self-handicappers consumed more self-handicapping tea. These learners claimed rather than practiced self-handicapping and more often made productive choices about studying, particularly after receiving feedback.

These findings support assumptions about learners' metacognitive awareness while studying. Learners seem to make cost-benefit analyses, taking into account prospective outcomes and consequences of claiming handicaps versus making choices in the self-handicapping panel. Hidden self-handicappers chose to merely claim rather than practice self-handicapping, a finding reported in other studies. Hirt and colleagues (1991) offered learners choices to claim stress as a handicap or behaviorally self-handicap by choosing not to practice for the task at hand. When providing opportunity to claim or practice self-handicapping, the majority of learners chose the less costly option of merely claiming rather than practicing self-handicapping. Similarly, Rhodewalt and colleagues (1984) demonstrated that professional athletes make the less costly choice of self-handicapping inconspicuously by maintaining rather than reducing practice before an important competition. This approach affords the attributional benefit of being able to blame the handicap for prospective failure without reducing chances for success.

Nevertheless, some learners self-handicapped more blatantly by selecting self-handicapping choices in the panel, abiding negative consequences of behavioral self-handicapping. These learners counterproductively self-regulate their learning. According to self-regulated learning theory (Winne & Hadwin, 1998), learners assess the task at hand, make inferences about their ability to succeed, and forecast possible consequences for however the task turns out. Perhaps blatantly self-handicapping learners lacked skills needed to successfully complete the task or had inapt standards which led them to underestimate their skills and thus forecast failure outcomes. This assumption is in line with research demonstrating self-handicappers doubt their ability to successfully complete academic tasks. Brown and Kimble (2009) found evidence that learners who were concerned about performance in an academic task were more likely to behaviorally self-handicap by reducing practice effort or selecting a music tape described as hindering performance, than learners confident in their ability to succeed in the task. Additionally, self-handicappers reported lower levels of self-efficacy (Gadbois & Sturgeon, 2011; Stewart & De George-Walker, 2014), self-concept (Ommundsen et al., 2005) and self-concept clarity across academic domains (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007).

Self-handicappers are theorized to aim for failure avoidance and thus, select a strategy that most likely achieves this goal, i.e., self-handicapping. Claiming or fabricating a handicap offers learners the attributional benefit of blaming the handicap for

prospective failure which reduces threats to self-esteem (McCrea & Hirt, 2011; Rhodewalt et al., 1991; Rhodewalt & Tragakis, 2014). Although costly, behavioral handicaps are credible excuses for prospective failure as they hinder performance and lower chances of success.

Offering learners multiple self-handicapping, neutral, and productive choices about studying not only revealed learners' preferences for specific choices but, more importantly, documented learners making self-handicapping choices when alternative choices were offered. This partly aligns with Tucker and colleagues' (1981) findings. In two experiments, they offered male learners choices between consuming an alcoholic beverage (self-handicapping choice) or, in experiment one, preparing for the task at hand (productive choice) and, in experiment two, reading task unrelated magazines (self-handicapping choice). Tucker and colleagues found evidence for male learners' preferences for specific choices. When male learners were offered a choice between an alcoholic beverage and procrastinating by reading magazines they consumed alcohol. However, male learners made a productive rather than the self-handicapping choice when offered opportunity to study. The authors' theorized offering learners a productive choice overshadows self-handicapping. However, when viewing this finding from the perspective of other research describing withdrawal of practice as a self-handicapping strategy (Brown & Kimble, 2009; Ferrari & Tice, 2000; Hirt et al., 1991; McCrea & Hirt, 2011; Wusik & Axsom, 2016), Tucker and colleagues' findings instead provide evidence for learners' preference for specific self-handicapping strategies, in this case, male learners' disinclination to self-handicap by consuming alcohol or withdrawing practice.

Tucker and colleagues' (1981) findings further suggest the array of choices offered to learners influences their decisions to self-handicap. Offering multiple choices learners may commonly be exposed to while studying increases ecological validity of interpretations and generalizability across handicaps. Self-handicapping researchers investigating how individuals perceive vignettes staging various contexts of self-handicapping suggest research should offer learners multiple choices to allow generalization of results beyond a specific handicap (e.g., Cox & Giuliano, 1999; D. S. Smith & Strube, 1991). However, almost all self-handicapping experiments limit learners' choices to one handicap. Some researchers acknowledge this pitfall by replicating their studies using different handicaps (Brown & Kimble, 2009; Kim et al., 2010; McCrea, 2008; McCrea & Flamm, 2012; Tice, 1991) but this approach still limits learners' choices

within the experiment and thus still limits interpretations about how self-handicapping observed in the laboratory matches self-handicapping in the real world where learners have choices about handicaps.

In this study, decision tree analyses shed light on learners' preferences for choices across web quests. In many cases learners' decisions to select a feature in the self-handicapping panel was predictive of choosing the same feature in a latter web quest. For example, the duration learners chose to listen to focus music in web quest three was accounted for by their decision to listen to focus music in web quests one and two. Other examples of carryover effects or learners' inclination to make a specific choice across iterations include listening to self-handicapping music, creating highlights, adjusting the frequency of popup ads, and drinking tea. But not all learners were consistent. Some learners showed preferences for a specific feature in the self-handicapping panel but experimented with different settings of this feature. For example, learners who chose to darken the screen (i.e., focus setting) for a short period of time in the first web quest, studied on average 14% of the time in web quest three with the self-handicapping setting for screen brightness. Learners also described selecting features in the self-handicapping panel because they "prefer", "liked" or "enjoyed" them. Rationales provided for reluctance to choose certain features were that learners "don't prefer" or "don't like" these features. This further emphasizes the importance for self-handicapping research of offering learners multiple choices while approximating more authentic learning situations and decision making processes of learners while studying.

5.4. How do Learners' Choices in the Self-handicapping Panel Change across Task Iterations?

General interaction with the self-handicapping panel did not differ across task iterations, however, three patterns among the 14 possible choices in the panel emerged: moderate, inactive, and active use of the self-handicapping panel. In the majority of cases, the self-handicapping panel was moderately used with the predominant preference being blocking popup ads across web quest. Another cluster of learners across web quests was described by a lack of interaction with the self-handicapping panel. Learners in this cluster studied with the default setting of infrequently appearing popup ads. The cluster containing learners who sought answers to web quests while most actively making choices in the self-handicapping panel mainly chose self-

handicapping and focus settings for screen brightness and popup ads, consumed more self-handicapping tea, and listened longer to music. Overall, it appears learners were less active in the third web quest compared to the first or second web quest. This observation, however, did not influence cluster formation.

The bulk of self-handicapping research so far has limited learners' choices to one occasion for self-handicapping, hampering investigation of learners' metacognitive control involved in self-handicapping. Alter and Forgas (2007) offered learners two occasions for self-handicapping in which learners were offered the binary choice of consuming tea described as self-handicapping or performance enhancing. After drinking tea, they were offered another binary choice of practising for the task at hand or reading a book. Although it is debatable to what extent these choices are comparable, it appears more learners procrastinated by reading a book than consumed self-handicapping tea. 64% of learners receiving non-contingent and 39% receiving contingent success feedback procrastinated. In contrast, 52% of learners selected the self-handicapping tea after receiving non-contingent compared to 26% receiving contingent success feedback. This indicates learners more often chose the later handicap which contrasts observations in this study that learners made fewer choices in the later web quest. However, Alter and Forgas (2007) offered choices sequentially, and learners did not complete a task and receive feedback between the two occasions for self-handicapping, making their findings more comparable to learners' choices within a web quest rather than across task iterations. Additionally, it should be noted that the sequence of choices may have influenced learners' self-handicapping which precludes interpretations about learners' preferences.

Decision tree analyses revealed learners' choices to claim handicaps were accounted for by previously claimed handicaps. Learners claiming few versus numerous handicaps for web quest one maintained this pattern in subsequent web quests. Coudavylle and colleagues (2020) offered high school learners three occasions to claim handicaps that could hinder performance in physical exercises. The motivational climate was manipulated for each occasion so that changes in claimed self-handicapping can be attributed to specific motivational climates. Conditions are not comparable among the three occasions to claim handicaps, prohibiting interpretations of how claimed self-handicapping changes across task iterations, but also how decisions to claim handicaps were formed.

Although learners claimed and practised behavioral self-handicapping in the present study, the decision to claim handicaps appears to be independent of choices to behaviorally self-handicap. Even though claimed self-handicapping is positively associated with self-reported behavioral self-handicapping (e.g., Feick & Rhodewalt, 1997; Rhodewalt & Hill, 1995), research is sparse comparing learners' preferences for merely claiming versus actually practising self-handicapping. Among studies offering learners opportunity to claim and practise self-handicapping, most found evidence for uptake of both choices (e.g., Hobden, 1999; Snyder et al., 2014; Thompson & Hepburn, 2003; Thompson & Richardson, 2001). Hirt and colleagues (1991) offered learners choices not to practise for an upcoming task or to claim high levels of stress as a means to handicap performance. The majority of learners chose to claim stress rather than withdrawing practise. While this provides evidence for learners' cost-benefit analyses when deciding to self-handicap, it does not explain variables involved in this decision. It is also unknown whether this finding can be generalized to other handicaps.

Two opposing hypotheses were investigated across task iterations: learners' choices to productively versus counterproductively self-regulate learning. Evidence supporting both hypotheses was found in the present study. The majority of the 47 learners (69% of all learners) who changed from productive to counterproductive approaches to learning or vice versa over time, balanced productive and self-handicapping choices. Twelve of the 47 learners (26%) made choices shifting to more productive approaches about learning and 10 of the 47 learners (21%) repeatedly made self-handicapping choices.

Learners' choices to counterproductively self-regulate learning over task iterations was operationalized as selecting less favorable approaches to studying over time. This included shifts from productive to neutral or to self-handicapping choices, or repeatedly choosing to self-handicap. As an example, choices to change the setting for screen brightness from "focus" to "self-handicapping" in subsequent web quests was a shift to self-handicapping. Six learners self-handicapped repeatedly across task iterations, making up to four decisions across iterations classified as counterproductive approaches to studying. For example, a learner shifted from studying with infrequently appearing popup ads and the "focus" setting for screen brightness in web quest one to increasing the frequency of popup ads and procrastinating on web quest two, and switching to a "self-handicapping" setting of screen brightness in web quest two and

three. In contrast to a series of counterproductive self-regulated learning choices, the majority of productive self-regulated learners made only one choice classified as a shift toward productive self-regulated learning. Perhaps learners were more determined to self-handicap than choosing productive approaches to studying.

These findings are in line with evidence from longitudinal research about self-handicapping. Zuckerman and colleagues (1998) compared undergraduate learners' academic achievement, self-reported self-handicapping, and well-being at the beginning and he end of a semester. High scores on the self-handicapping survey were positively associated with negative aspects of well-being and reduced academic achievement. The authors theorized self-handicapping and reduced well-being reinforce each other as a downward spiral of low achievement. The majority of self-handicapping researchers agree that self-handicapping is a concern in education as it undermines academic achievement (e.g., Schwinger et al., 2014; Urdan, 2004), motivation (e.g., De Castella et al., 2013; Ommundsen et al., 2005; Stewart & De George-Walker, 2014; Zuckerman & Tsai, 2005), productive approaches to studying (e.g., Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007; Warner & Moore, 2004; Zuckerman & Tsai, 2005), and well-being (e.g., Kim et al., 2010; Zuckerman et al., 1998; Zuckerman & Tsai, 2005). It is theorized that these unfavorable associations with self-handicapping promote self-handicapping choices. Findings of this study provide evidence that self-handicappers repeatedly choose counterproductive approaches to studying, shedding light on how correlations between self-handicapping and negative consequences come about.

Two learners chose more ambiguous approaches to self-handicapping. These learners balanced productive and counterproductive approaches to studying from the first to the second web quest, but shifted toward counterproductive self-regulated learning in the third web quest. For example, one learner completed web quest one partly with a neutral and "self-handicapping" setting for screen brightness. In web quest two, this learner adjusted screen brightness to the "self-handicapping" setting again, listened to self-handicapping music, and consumed neutral tea. Then, in web quest three, the learner made the self-handicapping choice to increase screen brightness but did not make choices classified as shifts toward productive self-regulated learning. This pattern was previously observed in the self-handicapping literature, particularly in research investigating music as a handicap. Researchers offered learners a choice between four to eight music tapes with labels ranging from very distracting to very

helpful. Choices of music tapes described as slightly or moderately distracting were classified as ambiguous handicaps, while choosing the tape labelled “very distracting” was described as an unambiguous handicap. In parallel with findings of the present study, learners made use of unambiguous and ambiguous handicaps (e.g., Drexler et al., 1995; Mello-Goldner & Wurf, 1997; Newman & Wadas, 1997, Tice, 1991).

Besides detrimental effects, there is evidence for short-term benefits of self-handicapping. Alter and Forgas (2007) offered learners two occasions for self-handicapping: consuming “self-handicapping” instead of “focus” tea, and reading a book instead of practising for the task at hand. After watching a video inducing positive mood, learners consumed more “self-handicapping” tea and spent more time reading a book than learners who watched videos inducing a neutral or negative mood. Self-handicapping may be a way to maintain good mood by postponing negative emotions associated with prospective failure. Drexler and colleagues (1995) drew similar conclusions. In their experiment, learners who chose to listen to “self-handicapping” music were more likely to maintain positive mood than learners selecting “focus” music tapes. Similarly, Deppe and Harackiewicz’s (1996) findings suggest self-handicapping may be a means to maintain intrinsic motivation. Learners who self-reported high levels of behavioral self-handicapping and self-handicapped by scarcely practising for a pinball game enjoyed playing pinball more than other learners who made the productive choice of practising. These authors theorized that blaming the handicap for failure affords learners’ continued enjoyment of playing pinball. Considering these short-time benefits of self-handicapping, it is plausible that learners who made self-handicapping choices shifted to more productive approaches to studying over time.

In this study, twelve learners productively self-regulated learning across task iterations. Productive self-regulated learning was described by choices shifting from self-handicapping to neutral or productive approaches to studying, as well as repeatedly making productive choices about studying across the three web quest tasks. For example, learners who made the productive choice of highlighting text while listening to “self-handicapping” music in web quest one, continued with the productive choice to create highlights but not listing to “self-handicapping” music in the later web quests. This suggests learners exercise agency to make choices about learning and their study environment.

Learners' productive self-regulated learning is also evident in their written justifications for their choices in the self-handicapping panel. The majority of learners described making choices to study productively. For example, one learner explained making choices "mostly to prevent distractions and improve concentration." Similarly, a learner indicated reducing distractions such as popup ads or self-handicapping music "because when hearing my own native language, I was unable to concentrate on the words I was reading. I did not listen to music for the same reason." Rationales provided for changing the screen brightness were to "focus better on the content" or "make it easier to read and searching the key terms." One learner emphasized listening to music because "the music eased my mind from anxiety." Some learners reported highlighting information in the texts "for clarity," "to process what I was reading," or "so that I know where to look when I look for a specific answer." These quotes illustrate learners made conscious choices to select strategies to improve learning and mitigate possible distractions in their learning environment.

Twenty-five learners balanced choices between productive and counterproductive approaches to learning. For example, in web quest one, a learner studied with the neutral setting of infrequently appearing popup ads. In the second web quest, this learner made the productive choice of blocking popup ads but also chose to procrastinate. Learners' explanations for making choices like these substantiate they move through the cycle of self-regulated learning. Winne and Hadwin (1989) describe four phases of self-regulated learning. First, learners assess task characteristics and requirements in relation to their skills to forecast possible outcomes. Then, learners set goals (phase 2) and select strategies as a means to achieve these goals in phase three. In phase four, learners make judgements about their strategy selection, comparing their progress towards their goal against their metacognitive standards. If learners judge metacognitive standards are not met, they adjust their goals, strategy selection, or standards.

From some learners' justification of choices made in the self-handicapping panel, it is evident that they made choices they judged to be best suited for reading and searching texts to complete the web quest tasks. A learner explained their reluctance to listen to music as follows:

> “It usually depends on the task that I am doing if I would like to listen to music or not. For example, if I am doing mathematical equations, I can listen to "high-fi pop music" which is a mix of jazz and hip hop music, which by the way does not have any words in it (songs with lyrics distracts me). However, if I am reading a text that I need to remember, I prefer silence.”

Similarly, another learner described having “soft music playing in the background when I study, but I use it more when I'm doing assignments rather than study material for a test because when I play music while doing work I feel motivated, but I find music and studying can be difficult”. Another learner described their choice to stop highlighting information in the text because they judged “the information could be found without having to highlight, as highlighting is more useful when I have to memorize information.” These quotes indicate learners assessed task characteristics and considered them when judging the degree to which strategies would facilitate task completion.

Theoretically, self-handicappers are aware of their abilities to complete a task in relation to task requirements. Self-handicappers intentionally fabricate obstacles to performance to avoid failure (Berglas & Jones, 1978; Urdan & Midgley, 2001), indicating self-handicappers are aware of a potential mismatch between their ability, task requirements and strategy selection. This is in line with experiences learners shared after completing the study. One learner reflected about their experience while completing the web quest task: “It helped me practice reading. It… it made me notice that I need to read more carefully. It was a good practice.” Another learner emphasized they “really enjoyed the study… it’s like it helped me think about how I study… and… and I could see myself in many things.” Both learners described how they became aware about their studying while participating in the experiment, emphasizing their engagement in metacognitive monitoring.

Martin and colleagues (2003) interviewed learners about self-handicapping behaviors. Their findings indicate learners make conscious choices to self-handicap. One learner described grounds for this choice as “…then I’ve got the excuse if I don’t go well” (p. 5). In contrast, Gadbois and Sturgeon (2011), and Thomas and Gadbois (2007) demonstrated self-reported self-handicapping correlated negatively with self-reported metacognitive monitoring and control. However, self-handicapping research so far has not captured metacognitive monitoring or control of learners “in action.” The majority of

self-handicapping research relied on self-report measures and correlational designs. Prior to the current study, experimental research has not offered learners multiple occasions to choose among several neutral, productive, and counterproductive approaches to studying across task iterations. These limitations preclude investigating learners' adaptations of metacognitive monitoring and control. Some experiments did not even offer learners opportunity to experience their self-handicapping, neutral, or productive choice about learning while completing a task. These experiments concluded after learners chose a strategy but did not observe engagement in the assigned task (e.g., Brown & Kimble, 2009; McCrea, 2008; Shepperd & Arkin, 1989a). These approaches fall short of opportunities for metacognitive monitoring and control.

This study found evidence for learners' metacognitive control applied to regulate their learning. One learner explained: "I tried to listen to focus music during web quest 2 but found that to be distracting as well and focused much better when I turned the music off." This learner metacognitively monitored strategy selection while studying. They judged listening to "focus" music was a distraction to studying and, as a result, made the adjustment of stopping the music. Two other learners shared how they metacognitively monitored and controlled the frequency of popup ads while studying. One learner reported, "I originally left the ads on occasional and they did not bother me at first but they eventually become annoying and I chose to use ad block." The other learner explained how their goals shaped judgement about popup ads: "Pop up ads are not that distracting. when I am a little bored from studying, pop up ads can bring back my energy and gets me excited because they are fun to watch. However, when was too focused on the subject pop ups were annoying and I quickly closed them." The majority of learner's descriptions of metacognition can be classified as productive approaches to studying rather than counterproductive. Perhaps, learners were reluctant to share their rationale for self-handicapping due to social desirability or to avoid implications of reducing credibility of the handicap.

Learners' justification of their choices in the self-handicapping panel also supported the view that self-regulated learners design and conduct experiments about their learning. One learner described it this way: "I wanted to try different ways to check if the selections actually mattered. I figured out that bright screen and pop up ads are very distracting." Another learner described experimenting how tea affects their learning: "I tried two teas, the focused one and the distracting one. I don't see a difference in my

performance that was influenced by the teas." This indicates the learner judged the effectiveness of tea against their goal (standard) to increase performance. Another learner explained experimenting with features of a strategy judged to be beneficial with the aim to increase efficiency: "Listening to rock music actually helped me but the volume does matter and it gave me the flow that I wanted." Another learner appears to have tried out a new strategy that had not yet been automatized: "I tried highlighting and tagging information, but gave up part way through each time, as I found it too tedious." Although automating learning strategies requires effort, these quotes suggest benefits of encouraging learners to be learning scientists who conduct experiments about their learning and explore new strategies.

Given that the majority of learners who made productive choices about learning over time received non-contingent success feedback to promote self-handicapping choices, and the large number of learners who balanced productive and counterproductive choices over time, encouraging learners to explore their learning and prompting them with productive approaches to learning might be particularly beneficial for learners who are likely to counterproductively self-regulate their learning. It appears that introducing learners to a multitude of approaches to learning encourages them to explore different approaches and observe how they affect learning and learning outcomes. Accordingly, making learning strategies and their implications explicit to learners appears to facilitate learners' metacognitive awareness, monitoring, and control and modestly elevate productive self-regulated learning. Future research is needed to examine this hypothesis, particularly studies that use longitudinal designs to investigate long-term effects.

5.5. Limitations and Conclusions

Addressing methodological issues of self-handicapping experiments, this study examined fine-grained trace data about self-handicapping as learners learn across task iterations. Building on prior research, multiple self-handicapping, neutral, and productive choices about learning were offered in the self-handicapping panel, the proposed behavioral measure for self-handicapping. Self-handicapping was operationalized as infrequently using learning strategies described as beneficial (e.g., highlighting text) or making choices to undermine learning (e.g., listening to self-handicapping music).

High frequencies of zero-values, describing an absence of choices in the self-handicapping panel, lower statistical power to detect effects. Replicating this study with a larger sample size would better test associations of choices made in the self-handicapping panel to variables, representing convergent and discriminant characteristics of the construct of behavioral self-handicapping.

Contingency of feedback was manipulated to afford comparisons of learners likely to self-handicap and learners likely to make productive choices about learning. In contrast to prior research, contingency of feedback was not statistically significantly related to claimed or behavioral self-handicapping (e.g., Deppe & Harackiewicz, 1996; Higgins & Harris, 1988; Rhodewalt & Davison, 1986). Learners' descriptions of feedback revealed some of them may have experienced contingent success feedback as if it was non-contingent, potentially clouding effects. Future research should examine contingency of feedback when tracing self-handicapping choices as learners learn across task iterations.

In this study, learners were classified as blatant or hidden self-handicappers based on claimed handicaps and choices among options in the self-handicapping panel. In contrast to blatant self-handicappers, hidden self-handicappers appear to claim rather than practise self-handicapping. This pattern has been previously observed in the self-handicapping literature (e.g., Hirt et al., 1991; Rhodewalt et al., 1984) and suggests learners make cost-benefit analyses when deciding to self-handicap. Offering learners in this study a larger array of choices uncovered learners' individual preferences for specific approaches to learning and afforded more authentic decision-making processes compared to previous self-handicapping experiments (e.g., Berglas & Jones, 1978; Cox & Giuliano, 1999; Drexler et al., 1995; Elliot et al., 2006; Harris & Snyder, 1986; McCrea & Hirt, 2011; Snyder et al., 2014). This elevates ecological validity and generalizability beyond one specific handicap. Moreover, it highlights the importance of offering learners multiple choices in self-handicapping research.

The bulk of self-handicapping research limited learners' choices to one occasion for self-handicapping. This precludes opportunity to examine metacognitive monitoring and control. This study makes the novel contribution of examining self-handicapping over task iterations, investigating hypotheses about whether learners self-handicap or self-regulate learning over time. Evidence supports both hypotheses. Ten learners self-

handicapped repeatedly across task iterations. This is in line with correlations between self-handicapping and variables that undermine learning which are speculated to reinforce self-handicapping choices (De Castella et al., 2013; Gadbois & Sturgeon, 2011; Kim et al., 2010; Ommundsen et al., 2005; Schwinger et al., 2014; Thomas & Gadbois, 2007; Urdan, 2004; Zuckerman et al., 1998; Zuckerman & Tsai, 2005). However, the majority of learners balanced productive and counterproductive choices about learning and twelve learners made more productive choices about learning across task iterations.

Learners' justifications of choices in the self-handicapping panel revealed learners' metacognitive awareness, monitoring, and control of choices to improve learning. Although self-reported self-handicapping is negatively correlated with self-reported metacognitive monitoring and control (Gadbois & Sturgeon, 2011; Thomas & Gadbois, 2007), prior self-handicapping research has not examined metacognition "in action." Contradictory findings of correlational versus experimental designs for self-handicapping research like this substantiate concerns about possible conceptual differences in operationalizing self-handicapping, suggesting avenues for future research.

Learners' explanations about interacting with the self-handicapping panel provide evidence they metacognitively monitored choices and adjusted selections when judged insufficient in relation to their metacognitive standards. Learners conducted experiments to explore the effectiveness of choices in the self-handicapping panel, interpreted their results, and adjusted their learning accordingly. Encouraging the learning scientist in learners to experiment with learning appears to promote learners' metacognition and may reduce tendencies to self-handicap. Future research is needed to substantiate this hypothesis. Overall, more research gathering fine-grained data about self-handicapping is needed to add details to the abstract picture of self-handicapping we have today.

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Appendix A.

Web Quests and Texts for the Comparison and Experimental Group.

Web Quest 1: Spanish Theatre

How was Spanish theatre in the late seventeenth century influenced by politics at the time?

The tension between Don Juan José of _____ , Mariana of _____, and their respective political factions was so prominent it influenced Calderón de la Barca's works. In his play _____, concerns and fears over these political terrains are present. The duality of progressive forethought cast against the status quo, when _____ and _____ are divided against Minerva and _____, is emblematic of Don Juan's opposition to Mariana and his coups on Madrid.

Texts for the Comparison Group

John of Austria the Younger

John of Austria the Younger (7 April 1629 – 17 September 1679) was a Spanish general and political figure.

His mother was María Calderón (La Calderona), a popular actress, who was forced into a convent shortly after his birth. He was raised in León by a woman of modest circumstances who likely did not know his parentage, though he received "a careful education" at Ocaña (Toledo).

He was the only bastard son of Philip IV of Spain who was acknowledged by the King. He was also trained for military command and political administration. In 1642, the King recognized him officially as his son, and John began his career as a military representative of his father's interests.

John advanced the causes of the Spanish Crown militarily and diplomatically at Naples, Sicily, Catalonia, the Netherlands, Portugal, Dunkirk and other fronts, and remained a popular hero even as the fortunes of Imperial Spain began to decline.

John might not have lost the confidence of his father, if Queen Mariana of Austria had not regarded him with distrust and dislike. Mariana was the mother of the sickly Infant Charles, the only surviving legitimate son of the King, John was sent to his command at Consuegra. After the death of Philip IV, in 1665 John became the recognized leader of the opposition to the government of Philip's widow, the regent. She and her favorite, the German Jesuit Juan Everardo Nithard, seized and put to death one of John’s most trusted servants, Don Jose Malladas.

John, in return, put himself at the head of a rising in Aragon and Catalonia, which led to the expulsion of Nithard on 25 February 1669. John was, however, forced to content himself with the viceroyalty of Aragon. In 1677, the queen mother aroused universal opposition by her shameless favor for Fernando de Valenzuela. John was able to drive her from court, and establish himself as prime minister. Great hopes were entertained for his administration, but it proved disappointing and short. John died on 17 September 1679, possibly by poison.

His name featured prominently in the Popish Plot fabricated by Titus Oates in 1678. Oates unwisely claimed that he met John in Madrid. However, when questioned closely by Charles II, who met John in 1656, it became clear that Oates did not know how John looked like, confirming the King's suspicion that the Plot was an invention.

Pedro Calderon de la Barca

Pedro Calderón de la Barca y Barreda González de Henao Ruiz de Blasco y Riaño, usually referred to as Pedro Calderón de la Barca (1600 –1681), was a dramatist, poet and writer of the Spanish Golden Age. During certain periods of his life he was also a soldier and a Roman Catholic priest. When he was born, the Spanish Golden Age theatre was defined by Lope de Vega. However, Calderón developed it further and his work is now regarded as the culmination of the Spanish Baroque theatre. Calderón is one of Spain's foremost dramatists and finest playwrights.

Calderón realized that the structure of the baroque play was entirely artificial. He therefore integrated meta-theatrical techniques in his plays, such as letting his characters read about clichés the author is using, which they are then forced to follow. Some of the most common themes of his plays were heavily influenced by his Jesuit education. For example, he liked to confront intellect with instinct, reason with passion, or understanding with will. Similar to many writers in the Spanish Golden Age, his plays parallel his vital pessimism, that is only softened by his rationalism and his faith in God. The anguish and distress commonly found his work is better exemplified in one of his most famous plays, La Vida es sueño, Life is a Dream, in which Segismundo claims:

What is life? A frenzy.
What is life? An illusion,
A shadow, a fiction,
And the greatest good is small;
For all of life is a dream,
And dreams, are only dreams.

Indeed, his themes tended to be complex, philosophical, and express complicated states of mind in a way that few playwrights have been able to achieve.

Playing the Court

In the 17th century prolific playwrights enhanced dramatic traditions of theatre in Spain. In the 1670s political conflicts emerged between Queen Regent Mariana of Austria and her illegitimate stepson Don Juan Jose, as their opposing factions vied to dominate the terrain of courtly politics in Madrid. This led to considerations of the political anxieties produced by the topic of succession in Bances Candamo's political trilogy: Cómo se curan los celos y Orlando Furioso, La Piedra filosofal, and El esclavo en grillos de oro.

Concerns over these political tensions are also involved in Calderón de la Barca's works: Fieras afemina amor and La estatua de Prometeo. Fieras afemina amor reflects the dramatic work and the real-life tension of and around the court. For instance, Hércules' brutish character would have been reminiscent of courtiers' view of Don Juan. Additionally, Hércules' loyalty to the king also mirrors doubts about Don Juan's loyalty to the crown after the death of Felipe IV. In his play La estatua de Prometeo the central theme parallels the uncertainty about the current political situation in Spain in the 1670s. Palas and Epimeteo's opposition to Minerva and Prometeo are symbolic for conflicts between Don Juan and Mariana but also reflect Don Juan's coups on Madrid.

Text for the Experimental Group

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Calderón de la Barca integrates current events, political figures, clichés, and elements from other works in his plays as interpolated stories. For example, the Invisible Mistress plot that is central in Calderón play The Phantom Lady also appears in the Italian novella by Masuccio Salernitano and Matteo Bandello.

The Phantom Lady is a cloak and sword play (de capa y espada) which follows the plot of the Invisible Mistress. This plot derives from the myth of Cupid and Psyche, but inverts the role of the protagonists. In the plot, it is the man's curiosity which leads him to meet and fall in love with the invisible woman. The invisible woman is either hidden, veiled or encountered in the dark.

The Phantom Lady had been interpreted from many points of view. Those who emphasized the tragic elements in the work point to the tragic references in the first scene, the surrounding darkness, the fact that Doña Ángela constantly complains that her brothers have imprisoned her, and to the rivalry between the two brothers. Some scholars focused on the magical and so-called superstitious elements or feminist aspects of the play. Others studied the economic and political subtexts, claiming that the play reflects the economic policies of the Count-Duke of Olivares.

Web Quest 2: Yeri Language

How is gender assigned in Yeri?

Yeri is an endangered _____ language spoken in _____, Papua New Guinea.

In comparison to many European languages, gender is a _____ category in Yeri. The assignment of gender in lower-level animals or inanimate objects appears to be determined by some _____ principles related to _____ and _____

Texts for the Comparison Group

Languages of Papua New Guinea

The languages of Papua New Guinea today number over 850. These languages are spoken by tribal groups in Papua New Guinea and Indonesia. In 2006, Prime Minister Sir Michael Somare stated that "Papua New Guinea has 832 living languages (languages, not dialects)", making Papua New Guinea the most linguistically diverse place on the Earth. Its official languages are Tok Pisin, English, Hiri Motu, and Papua New Guinean Sign Language. Tok Pisin, an English-based creole, is the most widely-spoken language, serving as the country's lingua franca. Papua New Guinean Sign Language became the fourth official language in May, 2015, and it is used by the deaf population throughout the country.

The Torricelli languages are a family of about fifty unofficial languages of the northern coast of Papua New Guinea. Only about 80,000 people speak these languages. The name of this family of languages derives from the Torricelli Mountains, a mountain range in Sandaun Province in north-western Papua New Guinea. The most populous and well known Torricelli language is Arapesh, with about 30,000 speakers. In contrast, the Torricelli language Yapunda, or Yeri is only spoken by approximately 100 people living in the Yapunda village.

Among Papuan languages, the Torricelli languages are unusual in having a basic clause order of SVO (subject–verb–object). In contrast, most other Papuan languages have SOV order. It was previously believed that the Torricelli word order was a result of contact with Austronesian languages. It is now thought more likely that the SVO order was present in the Torricelli proto-language.

Grammatical Gender

In linguistics, grammatical gender is a specific grammatical form of noun-class system in which noun classes form an agreement system with another aspect of the parts of speech, such as adjectives, articles, pronouns, or verbs. This system is used in approximately one quarter of the world's languages. In these languages, most or all nouns inherently carry one value of the grammatical category called gender. These values that are present in a language (of which there are usually two or three) are called

the genders of that language. According to one definition: "Genders are classes of nouns reflected in the behavior of associated words."

Common gender divisions include masculine and feminine; masculine, feminine and neuter; or animate and inanimate. In a few languages, the gender assignment of nouns is solely determined by their semantics or attributes, like biological sex, humanness, or animacy. However, in most languages, this semantic division is only partially valid, and many nouns may belong to a gender category that contrasts with their meaning (e.g. the word for "manliness" could be of feminine gender). In this case, the gender assignment can also be influenced by the morphology or phonology of the noun, or in some cases can be apparently arbitrary.

Grammatical gender manifests itself when words related to a noun like determiners, pronouns or adjectives change their form (inflect) according to the gender of the noun they refer to (agreement). The parts of speech affected by gender agreement, the circumstances in which it occurs, and the way words are marked for gender vary between languages. Gender inflection may interact with other grammatical categories like number or case. In some languages, the declension pattern followed by the noun itself will be different for different genders.

Gender in Yeri

In Yeri, humans and higher-level animals are typically assigned gender on the basis of natural sex. The gender of human nouns is determined by the basis of biological sex. For example, nua ‘mother’ refers to a female human. As such nua has feminine gender, where the third person singular feminine subject prefix w- occurs.

Along the same lines, since nena ‘father’ is biologically male, this noun is assigned with masculine gender and triggers the third person singular masculine subject prefix n-.

Lower-level animals, typically non-domesticated smaller animals, and inanimate objects are usually not assigned a gender on the basis of biological sex. Gender assignment seems to be somewhat more fluid in Yeri. Instead, there are some semantic principles which may influence which gender is assigned. At a very general level, there appears to be a tendency for short, round objects to trigger feminine gender assignment,

while tall, long, thin, or particularly big objects trigger masculine gender assignment. For example, miakua, ‘frog’, hapini ‘potato’, and libi ‘mango’ are typically feminine, while harkanogil ‘snake’, likil ‘long bamboo’, and siahera ‘crocodile’ are typically masculine. This size and shape association with gender has been noted for several other languages found in Papua New Guinea.

Despite the semantic principles, lower-level animals and inanimate nouns frequently show gender assignment in different contexts, with the same noun triggering masculine gender morphemes in some contexts and feminine gender morphemes in other contexts. For example, speakers judge the nouns wonela ‘centipede’, yati ‘sago palm, sago jelly’, and nalu ‘cassowary’ as equally acceptable with either feminine or masculine gender assignment. Yeri lower-level animals and inanimals typically do not show a fixed gender but are freely varying. Gender assignment does not change the meaning for many nouns.

Yeri is a unique language in many ways. Yeri’s fluid classification of gender is the only criteria distinguishing it from Germanic languages (e.g., Dutch, German, English) and Romance languages (e.g., Italian, Spanish, French), spoken in Europe.

Texts for the Experimental Group

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The Torricelli languages occupy three geographically separated areas. It is speculated these languages emerged due to geographical separations between migrating speakers of Sepik-languages several centuries ago.

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Gender Assignment

There are three main ways by which natural languages categorize nouns into genders: logical or symbolic similarities in their meaning (semantic), other nouns that have similar form (morphological), and arbitrary convention (lexical, possibly rooted in the language's history). In most languages that have grammatical gender, a combination of these three types of criteria is found, although one type may be more prevalent.

In some languages, the gender of a noun is directly determined by its physical attributes (sex, animacy, etc.), and there are few or no exceptions to this rule. The Dravidian languages for instance use this system. Overall, there are relatively few such languages.

In some other languages, the gender of nouns can again mostly be determined by physical (semantic) attributes, although there remain some nouns whose gender is not assigned in this way (Corbett calls this "semantic residue"). The world view (e.g. mythology) of the speakers may influence the division of categories.

An example is the Zande language, which has four genders: male human, female human, animal, and inanimate. However, there are about 80 nouns representing inanimate entities, which are nonetheless animate in gender: heavenly objects (moon, rainbow), metal objects (hammer, ring), edible plants (sweet potato, pea), and non-metallic objects (whistle, ball). Many have a round shape or can be explained by the role they play in mythology.

The Ket language has three genders (masculine, feminine, and neuter), and most gender assignment is based on semantics, but there are many inanimate nouns outside the neuter class. Masculine nouns include male animates, most fish, trees, the moon, large wooden objects, most living beings and some religious items. Feminine nouns include female animates, three types of fish, some plants, the sun and other heavenly objects, some body parts and skin diseases, the soul, and some religious items. Words, for part of a whole, as well as most other nouns that do not fall into any of the aforementioned classes, are neuter. The gender assignment of non-sex-differentiable things is complex. In general, those of no importance to Ket are feminine, whereas objects of importance (e.g. fish, wood) are masculine. Overall, Mythology can have a significant role in gender assignment.

Web Quest 3: Open-ocean Polynya

How do Antarctic open-ocean polynya influence the abyssal ocean?

Polynya are areas of _____ in the sea that are _____ by ice. The Weddell Polynya influences abyssal ocean water mass properties and _____.

The model polynyas initially _____ the abyssal Southern Ocean and South Atlantic, but 2-3 decades after polynya cessation the same regions _____ as they relax toward their mean state.

Up to 10% of recently observed _____ in the abyssal Southern Ocean could be the result of the 1970s Weddell Polynya recovery.

Texts for the Comparison Group

Polynya

Polynya [pəˈlɪnjə] is a loanword from Russian: полынья (polynya) Russian pronunciation: [pəɬɨˈnʲja], which refers to a natural ice hole, and was adopted in the 19th century by polar explorers to describe portions of the sea that can be sailed on by ships or boats. Polynya is an area of open water that is surrounded by sea ice. It is now used as geographical term for an area of unfrozen sea within the ice pack. In past decades, for example, some polynyas, such as the Weddell Polynya, have lasted over multiple winters (1974–1976).

Polynyas are formed through two main processes:

- Sensible heat polynya: This polynya is thermodynamically driven. It typically occurs when warm water moves upward to the ocean surface and keeps the surface water temperature at or above the freezing point. This reduces ice production and may stop it altogether.
- Latent heat polynya: This polynya is formed through the action of katabatic winds or ocean currents which act to drive ice away from a fixed boundary, such as a coastline, fast ice, or an ice bridge. The polynya forms initially by the first pack ice of the year that is driven away from the coast, which leaves an area of open water within which new ice is formed. This new ice is then also herded downwind toward the first pack ice of the year. When it reaches the pack ice the new ice is consolidated onto the pack ice. This process continues over time, thus naming the latent heat polynyas as a major source of sea ice production in the Antarctic. The latent heat polynya is the open water region between the coast and the ice pack.

The North Water Polynya

The North Water Polynya or Pikialasorsuaq in Greenlandic (NOW) is a polynya (area of year-round open water surrounded by sea ice) that lies between Greenland and Canada in northern Baffin Bay. It is the world's largest Arctic polynya with a size of 85,000 km² (33,000 sq mi). This polynya creates a microclimate that provides a refuge for narwhal, beluga, walrus, and bowhead whales to feed and rest. While thin ice forms in some areas, the polynya is kept open by wind, tides and an ice bridge on its northern

edge. In the 19th century, whalers who relied on it for spring passage, called it the "North Water". This polynya is one of the most biologically productive marine areas in the Arctic Ocean.

There is evidence that the North Water was visited by the Vikings in southern Greenland in the 13th century. But it was not until 1616 that the discovery, captained by Robert Bylot and piloted by William Baffin, sailed into this region, naming its landmarks such as Sir Thomas Smith's Bay (now Smith Sound) and Lancaster Sound after those who financed their expeditions. Between the 15th and 19th centuries, European whalers arrived and hunted bowhead whales to the brink of extinction.

The Weddell Polynya

In the mid-1970s, an enormous open-ocean polynya developed in the Weddell Sea of the Southern Ocean of Antarctica, near the Maud Rise (i.e., an oceanic plateau in the Southern Ocean). This polynya is called the Weddell Polynya or the Weddell Sea Polynya

Between 1974 and 1976 it re-occurred every winter. From 1976 to 2015, it was rarely observed but it re-occurred in 2016 and 2017. The Weddell polynya in 2010 was smaller than the 1970s occurrence which had roughly the size of New Zealand (approx. 270,000 km^2 or 105,000 sq mi). In 2017 this polynya was approximately the size of Maine (90,000 km^2 or 35,000 sq mi).

Since the Weddell Polynya's occurrence, no polynya of similar size or duration has been observed in the region. A polynya of this magnitude could significantly affect global abyssal ocean properties through the perturbation of large Weddell Sea water masses and increased Antarctic Bottom Water formation. Antarctic Bottom Water is the dense water with high salinity that exists in the abyssal layer of the Southern Ocean.

However, the scarcity of 1970s Weddell Sea observations, coupled with the sparseness of abyssal ocean observations, make it difficult to study this phenomenon's oceanic impact without models. The GFDL CM2G coupled climate model was used to examine abyssal ocean changes. It revealed that Weddell Polynyas influence abyssal ocean circulation and water mass properties.

Abyssal ocean temperature, salinity, and water mass changes resulting from Weddell Polynyas are analyzed and compared to observations. First, the model polynyas seems to cool the abyssal Southern Ocean and South Atlantic. However, approximately 20-30 years upon decline of polynyas, they appear to warm this area. Composites of multiple, spontaneously-occurring polynyas further reveal that the recovery of the 1970s Weddell Polynya may be responsible for about 10% of the warming of the abyssal Southern Ocean in the past years.

During Weddell Polynyas, vigorous exchange occurs between the surface and deep waters, resulting in increased circulation and changes in water mass properties of the abyssal ocean are observed.

Test for the Experimental Group

Polynya

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In the mid-1970s, an enormous open-ocean polynya developed in the Weddell Sea of the Southern Ocean of Antarctica, near the Maud Rise (i.e., an oceanic plateau in the Southern Ocean). This polynya is called the Weddell Polynya or the Weddell Sea Polynya

Between 1974 and 1976 it re-occurred every winter. From 1976 to 2015, it was rarely observed but it re-occurred in 2016 and 2017. The Weddell polynya in 2010 was smaller than the 1970s occurrence which had roughly the size of New Zealand (approx. 270,000 km² or 105,000 sq mi). In 2017 this polynya was approximately the size of Maine (90,000 km² or 35,000 sq mi).

Since the 1970s, the polar Southern Ocean south of the Antarctic Circumpolar Current has freshened and stratified, which is likely a result of anthropogenic climate change. Such stratification may be responsible for suppressing the return of the Weddell Sea polynya.

Since the Weddell Polynya's occurrence, no polynya of similar size or duration has been observed in the region. A polynya of this magnitude could significantly affect global abyssal ocean properties. However, the scarcity of 1970s Weddell Sea

observations, coupled with the sparseness of abyssal ocean observations, make it difficult to study this phenomenon's oceanic impact.

In contrast, the North Water polynya and its ecosystem has been a popular study site for Western scientists. Since 1867, they have been trying to unlock the oceanographic and biological secrets of Arctic polynyas. Researchers have also conducted intensive studies on the region's response to global climate change and other topics.

The effects of climate change in the Arctic include rising temperatures, loss of sea ice, and melting of the Greenland ice sheet with related irregular cold temperatures, observed in recent years. Potential methane release from the region, especially through the thawing of permafrost and methane clathrates, is also a concern. The Arctic warms twice as fast compared to the rest of the world. The pronounced warming signal, the amplified response of the Arctic to global warming, is often seen as a leading indicator of global warming. The melting of Greenland's ice sheet is linked to polar amplification, the larger change in temperature near poles than the planetary average. According to a study published in 2016, about 0.5 °C of the warming in the Arctic has been attributed to reductions in sulfate aerosols in Europe since 1980.

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Appendix B.

Additional Decision Trees

The following decision trees describe learners' choices of features in the self-handicapping panel that were explained by choosing the same feature in a previous web quest. Decision trees are visualized upside down. This means the root or inner node first created is displayed on the top (labeled "1" in the figures). Values of the response variable are illustrated in the box and whisker plots at the bottom of the figures. These plots indicate median and range of the observations.

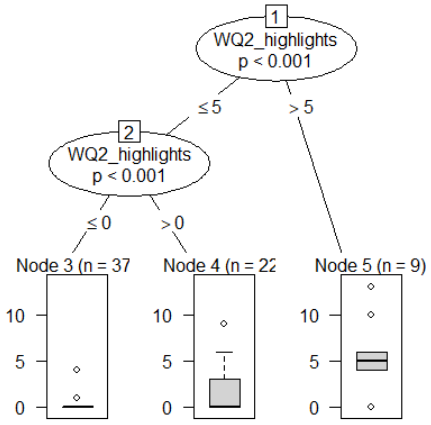

Figure B.1. Decision tree explaining learners' number of highlights in web quest three (response variable) with their number of highlights in web quest two (input variable). Box and whisker plots visualize values of the response variable.

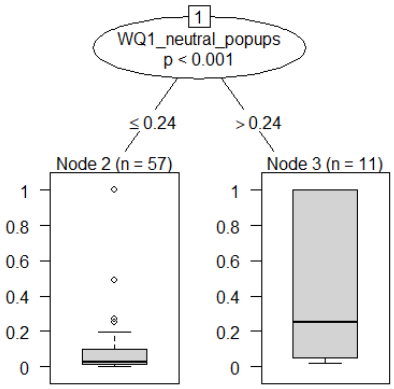

Figure B.2. **Decision tree explaining learners' time spent working on web quest two with a neutral setting of popup ads (response variable) with the time worked with the same setting for popup ads in web quest on--e (input variable). Box and whisker plots visualize values of the response variable.**

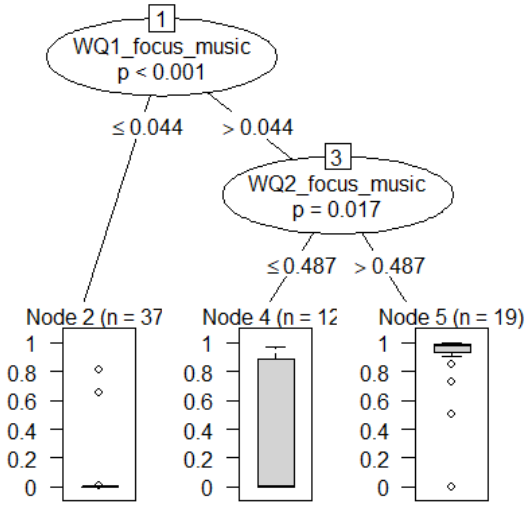

Figure B.3. **Decision tree explaining learners' time spent listening to focus music in relation to time on web quest three (response variable) with time listened to focus music in relation to time on web quest one and two (input variables). Box and whisker plots visualize values of the response variable.**

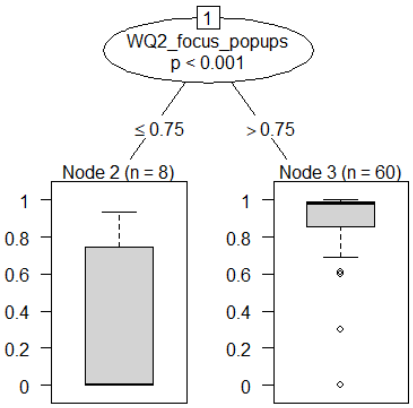

Figure B.4. Decision tree explaining learners' time worked on web quest two with the focus setting of popup ads (response variable) with time worked on web quest one with a focus popup ad setting (input variable). Box and whisker plots visualize values of the response variable.

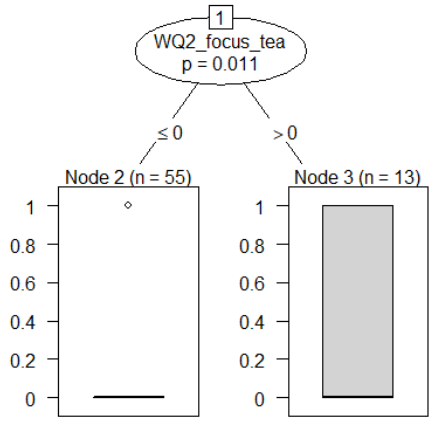

Figure B.5. Decision tree explaining learners' choice to drink focus tea in web quest two (response variable) with their choice to drink tea in web quest one (input variable). Box and whisker plots visualize values of the response variable.

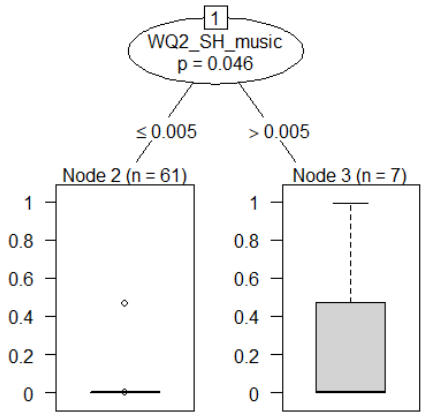

Figure B.6. **Decision tree explaining learners' time on web quest three listened to self-handicapping music (response variable) with time listened to self-handicapping music in web quest two (input variable). Box and whisker plots visualize values of the response variable.**