Passion for Science and the Pursuit of Scientific Studies: The Mediating Role of Rigid and
Flexible Persistence and Activity Involvement

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In a prevailing pedagogical paradigm that fuels students to excel in academics, limited initiatives exist guiding today's youth on how to find a balance and flourish beyond just grades. Indeed, when one thinks about academic achievement, the idea to persist automatically springs to mind. Persistence is often perceived as a predecessor to success (Author 1), and thus involves a certain willingness to continue expending effort in the face of obstacles in order to reach a specific goal. While it is almost unanimously agreed upon that a high degree of intensity in persistence usually predicts better outcomes, research is scarce on the qualitative differences that may exist in the way we persist and how they may lead to differential outcomes.

Imagine a scenario with two college students in their last semester of health sciences and preparing to apply to medical school. Having a passion for the field and being aware of the rigorous admission requirements (strong grades, letter of intent, interviews), both students will devote a significant amount of time studying to reach a high academic performance and will persist strongly toward their goal over the subsequent months. The first student may persist *rigidly* toward this goal while focusing almost exclusively on effectively fulfilling the admission requirements (e.g., studying very long hours to maintain high grades, writing multiple iterations of a letter of intent, and viewing or practicing interview scenarios on a daily basis) while neglecting other aspects of his or her life. While this student may experience some sense of satisfaction and contentment with this process, the narrow focus limits the experience of other important goals and outcomes such as spending quality time with family and friends. On the other hand, the second student may persist more *flexibly* toward the same goal, working hard toward his or her academic goal while still remaining involved in other goals (e.g., playing basketball with friends in the evenings) during the process. This broader focus should lead to a fuller range of experiences both within a specific activity (successfully meeting the admission

requirements) and in life, in general (spending quality time in leisurely activities).

In the above example, the two students persist differently toward the same goal. While both should achieve success in completing their specific academic goal, a flexible persistence should tend to also facilitate at least other life outcomes when compared to a rigid persistence. Of further interest is the type of motivational process leading one to persist in one way over the other. We believe that being passionate about a given activity (such as science) should lead one to persist strongly toward a related goal (such as applying into a STEM-related program). However, in line with the Dualistic Model of Passion (Author 2), we further posit that two types of persistence (rigid and flexible) exist as well, depending on the underlying form of passion (obsessive or harmonious). The present paper aims to test through a mediation model the presence of two types of persistence in education as described with the above examples, the potential role of passion as a determinant of persistence, and the role of persistence in academic and life outcomes.

Persistence

Researchers in education and in psychology have long held an interest about components of students' persistence (e.g. Tinto, 2006). The concept of persistence was initially defined as some form of sustained expansion of effort toward a goal as an objective feature of purposive behavior (McDougall, 1908). It was later described as a form of striving for the sake of achievement in spite of discouragement (Fernals, 1912). In education, particularly, persistence has more typically been defined as the antonym of attrition (Berger & Braxton, 1998). In recent years, persistence has also been coined as a perpetuation of effortful action despite failures, impediments, threats (Gimeno, et al., 1997), obstacles (Baum & Locke, 2004), or even fear (Norton & Weiss, 2009). In educational research, persistence is sometimes measured as the

equivalent of a form of intention to achieve a specific goal such as completing a high school degree (Author 1). Despite nuances that prevail in these conceptualizations, a commonality exists supporting the importance of a certain willingness to continue expending effort when facing challenges in a specific domain or activity to reach a specific goal.

Extrapolating from the various perspectives conceptualizing persistence, it seems that the level of intensity is the key to successfully reaching the desired goal, with high levels of persistence typically leading to higher levels of goal attainment (see Reeve, 2014). However, very little attention has been paid to the quality of persistence that may exist and how these may impact outcomes differently. Some authors have begun studying the quality of persistence by focusing on the adaptive function of being able to change the goal that one is pursuing or to disengage from the goal altogether. For instance, Brandtstädter and Renner (1990) posited that goal persistence could be explained in two ways: (1) In line with assimilative processes, whereby one would be engaged tenaciously in goal pursuit and striving with commitment and determination, as one feels that he or she can modify the environment and produce the necessary changes to successfully reach the desired goal, and (2) In line with accommodative processes, whereby one accepts to modify or rescale a goal and at times accepting to stop pursuing goals if necessary as one feels that he or she cannot fully affect the environment to reach the initial goal. A similar perspective has been proposed by Wrosch and colleagues (2003) who posited that goal pursuit can follow either the engagement or disengagement pathroad. While we do not question the usefulness of such strategies, at least in certain situations, it nevertheless remains that goal downscaling or even dropping goals is different from pursuing the original goal. Rather, we propose that there can be *qualitative* differences in how one keeps on persisting towards a given goal. Extrapolating from this perspective, we present a more nuanced approach to persistence as

posited by the DMP in the next section.

Persistence in Light of the Dualistic Model of Passion

Over the past decade, much research has shown that passion is a major driving motivational force (see review from Curran et al., 2015). Passion does not simply reflect a short-lived interest toward an activity; it is central in people's lives to the point where it represents an integral part of their identity (Bouizagarene et al., 2018). With numerous studies revealing that students are generally passionate for at least one educational activity such as music (Bonneville-Roussy et al., 2011, 2013), science (Mageau et al., 2009), dramatic arts (Author 3), and studies in general (Bélanger et al., 2013), there is no doubt that passion occupies a highly prevalent space in the education realm (Author 4). Consequently, students who find a passion for a particular school subject are likely to persist and to continue on in a profession they love.

Author 5 defined passion as a strong inclination toward an activity that people love, that they find important, and in which they invest considerable time and energy. Furthermore, according to the DMP, two distinct types of passion arise as a result of how it has been internalized in one's identity: (1) Harmonious Passion (HP) in which one's passion is autonomously integrated into his or her identity (Bouizegarène et al., 2018) and (2) Obsessive Passion (OP) in which one's passion is internalized into the person's identity through external and internal pressures such as feelings of social acceptance and self-esteem contingencies toward the activity that they love (Mageau et al., 2011).

Individuals with HP experience a strong desire to freely engage in the beloved activity while still remaining mindful and open to other experiences (Philippe et al., 2017; St-Louis et al., 2018). Such a sense of freedom coupled with the absence of conflict with other life pursuits (e.g., Bélanger et al., 2019) allows the person to persist flexibly in the loved activity and experience

positive outcomes such as flow, positive affect, and higher levels of performance (see Curran, et al., 2015; Authors 2 & 6). With HP, intensive engagement in the passionate activity can be achieved without neglecting other life goals, thus leading one to also experience outcomes in the rest of the person's life such as increased psychological well-being and positive interpersonal relationships, (e.g., Verner-Filion et al., 2017). Conversely, individuals with OP engage in the activity they love with lower levels of mindfulness, as well as conflict with other identity elements (Bouizegarène et al., 2018) thus leading to less adaptive outcomes within the activity such as negative affect (Author 7), guilt and frustration (Mageau et al., 2009; Ratelle et al., 2005), anxiety (Verner-Filion et al., 2014), and rumination (Carpentier, et al., 2012). Furthermore, OP leads to conflict between the passionate activity and other elements in the person's life (e.g., Boiché & Caudroit, 2019), thereby leading to negative outcomes within interpersonal relationships (Author 11), low psychological well-being (Philippe et al., 2009), and burnout (Author 9). Such a rigid way of persisting in an activity is characteristic of OP.

Passion-Based Outcomes in Education

A number of studies have supported the differential role of HP and OP in predicting important outcomes in education, such as the pursuit of excellence in one's studies (Authors 2 & 4) and performance through deliberate practice with student athletes (Author 8). In a study with high-school students, Ruiz-Alfonso and León (2017) found that HP for one's studies positively predicted motivation to learn which, in turn, positively predicted actual math performance. Other studies focusing on long-term performance have used achievement goals (Elliot & Harackiewicz, 1996) to demonstrate how students who were passionate about their studies (Author 3), music (Bonneville-Roussy et al., 2011), or sports (Author 8) engaged in processes leading one to commit to deliberate practice. In light of these studies, it seems that individuals with HP *flexibly*

persist in a passionate activity and achieve goals without necessarily having to neglect interests in other spheres of one's life such as positive relationships and psychological well-being (e.g., Bonneville-Roussy et al., 2011; Bonneville-Roussy et al., 2013; Verner-Filion et al., 2017).

With OP, a different scenario emerges. Despite leading to positive outcomes in terms of performance within the passionate activity, it also seems to lead to outcomes such as guilt, frustration, and anxiety (Mageau et al., 2009; Verner-Filion et al., 2014). This is possibly due to its internalization process being associated with some form of conflict associated with ego-invested self-structures. Furthermore, research suggests that OP leads to an imbalance between the passionate activity and other life goals (Boiché & Caudroit, 2019), thereby leading to negative outcomes in other life spheres such as lower well-being and burnout (Philippe et al., 2009; Author 1). Thus, those experiencing OP would tend to persist *rigidly* in the activity even when deemed inappropriate to continue (Stenseng, 2008) or when lower psychological wellbeing and burnout are at stake.

Drawing from the tenets of the DMP, different qualitative types of persistence seem to be displayed depending on the underlying form of passion. For instance, a rigid form of persistence is hypothesized to stem from OP as it would entail engaging and pursuing a goal with a narrow focus that is focused on either doing better than others (performance-approach goals) or avoiding doing worse than others (performance-avoidance goals) (Author 2). In relation to deliberate practice and performance, Bélanger and colleagues (2013, Study 4) showed that having an OP for one's studies led to enhanced performance when one's ego was threatened, and fear of failure was triggered. Thus, while a rigid persistence would facilitate reaching activity goals and experiencing some positive outcomes, this type of sustained engagement in the face of a deteriorating situation may potentially lead to less adaptive outcomes outside the passionate

activity. On the other hand, a flexible approach toward a passionate activity might provide one with more adaptive processes and experiences (Kashdan & Rottenberg, 2010), thus allowing one to remain involved in other life activities as well. Thus, it appears that individuals with HP are able to display flexible persistence and to disengage if they realize that other life goals need attention, thereby leading to more adaptive outcomes outside of the passionate activity.

The Present Research

In light of the above, there were four purposes to this research. First, we sought to test the existence of the two types of persistence in education, namely rigid and flexible persistence, leading to the validation of a scale assessing both constructs. Second, we also wished to test the differential role of HP and OP for one's academic studies in predicting flexible and rigid persistence, respectively. A third goal of this research was to test the role of persistence in the relation between passion and academic outcomes. Finally, a fourth goal of the present research was to test the potential benefits of flexible over rigid persistence in outcomes outside of the school environment (i.e., leading a well-balanced life).

These goals were tested in two studies in which we sought to test the role of passion for science as a determinant to the two types of persistence toward their goals in science. In addition, in Study 1, we investigated the differential role of flexible and rigid persistence in academic outcomes, including intentions to apply to university programs in STEM, as well as in life in general. Finally, Study 1 was replicated in Study 2, in which we measured actual university applications. In line with the above, we expected OP to be positively associated with rigid persistence and negatively so with flexible persistence and HP to positively predict flexible persistence. In turn, we expected both types of persistence to positively lead to academic outcomes, with only flexible persistence also leading to outcomes in life.

Study 1

The objectives of Study 1 were to: (1) test the validity of a new persistence scale in education, (2) test the associations between passion for and persistence in science, (3) test the role of persistence in academic and wellbeing outcomes; and finally (4) assess the mediating effect of persistence in the relationship between passion (OP and HP) for science and outcomes experienced inside and outside of school. Extrapolating from the review above and in line with the DMP, HP for science was expected to lead to a flexible form of persistence, and OP to rigid persistence. In turn, both types of persistence should be conducive to academic performance in science courses which would then lead to intentions in pursuing a STEM program at the university. Moreover, we posited that flexible (but not rigid) persistence should positively predict wellbeing outside the realms of the school context.

Method

Participants

Participants consisted of 591 (234M, 357F) science students enrolled in six different public, urban colleges from Eastern Canada. These colleges are considered equivalent to the two years spent from Grade 12 to the end of first year at university and cater mostly to youth between 17 and 19 years of age. This educational context represents a period of time where students are in transition between high school and university and begin to specialize in what they are passionate about. Participants were enrolled in preuniversity STEM programs, specifically in Health Sciences ($n = 337$), Pure and Applied ($n = 191$), and others such as environmental and computer science ($n = 63$). They were recruited from Year 1 ($n = 308$) and from Year 2 ($n = 266$) ($n = 17$ did not answer) and came from French-speaking ($n = 222$) and English-speaking ($n = 369$) institutions.

Data Collection and Analysis

Prior to data collection, the research was submitted for evaluation at the institution's ethics review board. Human subjects' approval was received in order to proceed with the data collection. A survey was administered by a trained research assistant in classrooms.

Questionnaires were answered in English or French depending on the language of instruction at the institution. In some cases where classroom visits were not possible, an online questionnaire was administered with the assistance of school personnel through the college's portal.

Data were analyzed using structural equation modeling with R, version 3.6.4, with robust full information maximum likelihood estimation (Raudenbush & Bryk, 2002). The following fit indices were used as guidelines: the comparative fit index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Squared Residual (SRMR) (Kline, 2011; Tabachnick and Fidell, 2007). Prior to analyses, all variables were examined for accuracy of data entry and fit between their distributions and the assumptions underlying maximum likelihood procedures (Tabachnick & Fidell, 2007). In terms of data screening for online surveys, we included an attention check to screen participants, multivariate outliers were deleted using the Mahalanobis distance, and univariate outliers were winsorized to three median absolute deviations around the median (Leys et al., 2013).

Measures

Participants were asked to complete scales that measured passion, persistence, intentions to pursue science at university, as well as outcomes related to academic performance and psychological wellbeing. All measures were on a scale from 1 ("I totally disagree") to 5 ("I totally agree"), unless otherwise indicated.

Passion. HP and OP for science were measured with an adapted version of the Passion

Scale (Marsh et al., 2013). They were adapted from the original one in Author 2 by changing the word “activity” to “science”. HP (e.g., “The new things that I discover in science allow me to appreciate it even more”, $\alpha = 0.85$) as well as OP (e.g., “I have almost an obsessive feeling for science”, $\alpha = 0.78$) were each measured with six items, respectively. The Passion scale has displayed high levels of reliability and validity (Marsh et al., 2013). Over 20 studies have confirmed its factor structure in a dozen languages and it has been found to be invariant across gender, languages, and types of activities (Marsh et al., 2013). Finally, it has been used with much success in several studies on education (e.g., Bélanger et al., 2013; Ruiz-Alfonso et al., 2019).

The Rigid and Flexible Persistence Scale. Items describing persistence were theoretically driven and based on the premises of the Dualistic Model of Passion (Author 3; Author 4). The scale reflects the rigid and flexible ways of how one becomes involved in activities that are important to them. Two 3-item subscales were used to assess flexible persistence (FP) (e.g., “I try to reach my goals in science, but not at the expense of other life goals”, “I work hard at my goals in science, but other things matter as well”, “I work hard to achieve a goal in science, but can stop if necessary”), ($\alpha = 0.64$) and rigid persistence (RP) (e.g., “When it comes to reaching my goals in science, nothing else matters”, “I am willing to do anything to reach the top in science”, “It is OK for me to focus only on goals in science to succeed in it”), ($\alpha = 0.72$). This 6-item persistence scale represents the shorter version of the original 8-item scale (Author 10).

Intentions. This single item measured students’ intentions to pursue sciences in higher education (e.g., “I have the intention of continuing in sciences at university”). This item was used as it was a key item in the intention measure used in Author 5.

Academic performance. Each participant was asked to report their overall average of their science courses on a scale from 1 (less than 60%) to 9 (95% - 100%). Students had received their most recent grades one month prior to this study.

Psychological wellbeing. This scale assesses students' life satisfaction (2 items), meaningfulness (2 items), and happiness (2 items) (Diener, Emmons, Larsen, & Griffin, 1985; Lyubomirsky & Lepper, 1999; Steger et al., 2006). Cronbach alpha for this scale was $\alpha = 0.84$.

Results and Brief Discussion

We used a Confirmatory Factor Analysis (CFA) to test the factor structure of six persistence items. In line with (Author 10), it was hypothesized that a two-factor structure would be extracted reflecting rigid and flexible persistence. The overall model yielded two factors with all items loading on the appropriate factor. Factor loadings ranged from 0.50 to 0.80 for rigid persistence and from 0.55 to 0.59 for flexible persistence with good fit indices, $X^2(8) = 22.297$, $p < .05$, CFI = .967, RMSEA = .055, SRMR = .029. The correlation between rigid and flexible persistence was $r = -.07$, $p > .05$. To test for measurement invariance, we subset the data into two smaller datasets with gender as the grouping variable and tested the same overall model for males and females separately before nesting them together (see Table 1).

[Insert Table 1 here]

Based on the fit indices, we concluded that the construct is equivalent across males and females and that it has the same meaning to them. Means, standard deviations, and correlations of all constructs used in Study 1 are presented in Table 2.

[Insert Table 2 here]

The model tested by structural equation modeling was composed of seven variables: two exogenous variables (i.e., HP and OP) and five endogenous variables (i.e., rigid and flexible

persistence, self-reported science grades, intentions to pursue a STEM program at university, and psychological wellbeing). We estimated covariances between both passion types and between the disturbance terms for mediators and outcomes, but omitted them from Figure 1 for clarity purposes. Although the persistence scale showed invariance across gender, there were significant mean differences between males ($M = 2.33$, $SD = 0.77$) and females ($M = 2.09$, $SD = 0.76$) on the OP scale $t(589) = 3.670$, $p < .001$, therefore we did include gender as a control variable in our model. The hypothesized model predicted that: (1) HP would be positively (and OP negatively) associated with flexible persistence, (2) OP would be positively associated with rigid persistence, (3) Both types of persistence would be associated with academic performance in science courses, which in turn would lead to intentions to pursue in sciences, and (4) Only flexible persistence would also be positively associated with psychological wellbeing. Overall, our proposed model in Study 1 had a good fit to the data: $\chi^2 = 32.138$, $df = 12$, $p = .001$, CFI = .961, TLI = .908, RMSEA = .053, 95% CI [.032, .076], and SRMR = .037.

Results from structural equation modeling (SEM) were found to support the study hypotheses. Specifically, results revealed that OP was positively associated with RP ($\beta = 0.39$, $p < 0.001$) and negatively with FP ($\beta = -0.24$, $p < 0.001$), whereas HP was positively associated with FP ($\beta = 0.42$, $p < 0.001$). Furthermore, self-reported science averages were positively related to FP ($\beta = 0.15$, $p < 0.001$), HP ($\beta = 0.16$, $p < .001$), and RP ($\beta = 0.08$, $p = .027$), which in turn led to intentions to pursue science at university ($\beta = 0.15$, $p < 0.001$). In addition, FP was positively associated to wellbeing outside of the school premises ($\beta = 0.12$, $p = 0.003$). Significant direct links were also observed between HP and WB ($\beta = 0.21$, $p < 0.001$), between HP and Grades ($\beta = 0.16$, $p < 0.001$), between OP and Intentions ($\beta = 0.19$, $p < 0.001$), and between RP and Intentions ($\beta = 0.18$, $p < 0.001$) (see Fig. 1).

[Insert Figure 1 here]

The significance of indirect effects was also tested using 500 bootstrap samples and the 95% bias-corrected confidence intervals (CIs) as suggested by Shrout & Bolger (2002). Our results confirmed the presence of seven significant indirect effects, thus providing support for the mediating role of persistence in the relationship between passion and outcomes. The standardized beta coefficients, *p* values, as well as 95% confidence intervals are shown below.

[Insert Table 3 here]

Results from Study 1 fully supported our hypotheses. First, we provided empirical evidence for the existence of the two types of persistence and the validity of the Persistence Scale in Education. Second, the present results also supported the hypothesis that both types of passion were determinants of the two types of persistence. Specifically, relationships were established whereby OP was positively related to rigid and negatively to flexible persistence, whereas HP was only positively associated with flexible persistence. Finally, our results supported the hypothesis that both types of persistence were positively associated with academic-specific outcomes, but only flexible persistence was also predictive of positive experiences related to the wellbeing in students' life in general. Moreover, as expected, the magnitude of relationships between the two types of persistence and outcomes differed and was greater with flexible than rigid persistence. Thus, these results support the hypotheses that the different types of persistence take origin in the two types of passion and in turn, the two types of persistence lead to positive academic outcomes. It is noteworthy that the presence of a direct path from HP to academic performance underscores the fact that other mediators may also be at play. Finally, only FP was found to predict an important life outcome, namely psychological well-being.

Study 2

The purpose of Study 2 was twofold: (1) to replicate and extend findings from Study 1 and (2) to test an additional mediator (in addition to persistence), namely involvement in extracurricular scientific activities, in the relationship between HP and similar outcomes as in Study 1. According to previous research findings regarding extracurricular activities (i.e., a non-mandatory activity organized by the school outside of class periods) as a means to prevent high school dropout and aspire the pursuit of postsecondary education (Farb & Matjsako, 2012), we wanted to test how science students' involvement in scientific extracurricular activities could predict and enhance academic-specific outcomes. To date, extracurricular activities have provided evidence of increased incentive to attend school (Deci & Ryan, 2000; Ryan & Deci, 2000), school perseverance (McCabe et al., 2018), as well as generalization effects of motivation to the school context (Denault & Guay, 2017); however, no studies to date have examined which motivational factors predict students' involvement in extracurricular activities and its potential impact on academic performance. Such studies are important because they provide a richer understanding of the extent to which academic and psychological factors influence students' pursuit of STEM programs in higher education.

In line with the above and the findings of Study 1, we hypothesized that HP for science would lead to flexible persistence and that OP would be positively associated with rigid persistence but negatively associated with FP. In turn, both types of persistence would positively predict science grades, but that only flexible persistence would lead to wellbeing experienced outside the realms of academics. Additionally, we postulated that involvement in scientific extracurricular activities would be related only to those experiencing HP (not OP) as they would have adopted a flexible approach with their studies and not be exclusively focused on academic performance. Moreover, we also expected involvement in scientific extracurricular activities to

be associated with academic performance in science courses based on past research leveraging associations between extracurricular activities and school perseverance (Denault & Poulin, 2017; Eccles & Roeser, 2009; McCabe et al., 2018; Thouin et al., 2018). Finally, we measured university science program applications instead of intentions. We expected that science grades would lead to future applications to STEM programs at universities. In summary, this model investigated five paths: (1) one leading to grades (and ultimately to STEM university programs) via HP and mediated by flexible persistence; (2) one leading to grades (and ultimately to STEM university programs) via OP and mediated by rigid persistence, (3) one leading to positive consequences of wellbeing via HP and mediated by flexible persistence, (4) one leading to negative consequences of wellbeing via OP and mediated by flexible persistence, and (5) one leading to grades (and ultimately to STEM university programs) via HP and mediated by involvement in extracurricular scientific activities.

Method

Participants and Procedures

The sample consisted of 196 (74M, 124F) second-year students (a different sample from Study 1) recruited from the same public Canadian colleges as in Study 1. Students were enrolled in various science pre-university programs, including Health Sciences ($n = 126$), Pure and Applied Sciences ($n = 60$), and Environmental Sciences ($n = 10$). The questionnaires were completed in classrooms and online near the end of the Winter semester. The same method of data collection and analyses were used as in Study 1. We chose to study only second-year students because the Winter semester is when applications to universities are completed and we were interested in this particular outcome.

Measures

Participants completed scales that measured passion, persistence, involvement in extracurricular activities, self-reported science grades, applications to science university programs, and psychological wellbeing. All items were measured on a scale from 1 (strongly disagree) to 5 (strongly agree), unless otherwise indicated.

Passion. Participants were asked to complete the same Passion Scale as in Study 1 measuring HP ($\alpha = .87$) and OP ($\alpha = .81$).

Persistence. Participants were asked to complete the same Persistence Scale as in Study 1. Cronbach alphas for rigid persistence was $\alpha = .68$ and for flexible persistence, $\alpha = .62$.

Extracurricular scientific activities. This scale was a yes or no choice and asked participants to name a science-related extracurricular activity (e.g., robotics club) they were participating in for the entire duration of the current semester. Involvement in extracurricular activities was coded as a dichotomous variable: 1 = No and 2 = Yes.

Self-reported science grades. Similar to the scale used in Study 1, we asked each participant to report their average of all science courses they had obtained since the beginning of their program, ranging on a scale from 1 (less than 60%) to 9 (95% - 100%).

Applications to STEM programs at university. This scale consisted of the total number of STEM university programs participants reported applying to. Counting the frequencies was important because it was indicative of the extent to which they intended to pursue within a STEM domain.

Psychological wellbeing. The same scale as in Study 1 was used to assess psychological wellbeing in Study 2, $\alpha = .81$.

Results and Brief Discussion

Means, standard deviations, and bivariate correlations are presented in Table 4. As in

Study 1, there were significant differences between males and females on the OP subscale in Study 2, therefore, we did control for gender (Male = 1, Female = 2) in our model. The following four hypotheses were tested using a SEM: (1) HP would be positively associated to FP, (2) OP was be positively associated to rigid persistence and negatively to flexible persistence, (3) Both rigid and flexible persistence would be associated with academic performance, which in turn would lead to applications in STEM programs at university, (4) Only flexible persistence would be expected to be positively relate to wellbeing, and (5) Extracurricular scientific activities would mediate the relationship between HP and grades (and ultimately to STEM university programs).

[Insert Table 4 here]

Results from SEM provided support for the model. Overall, the proposed model in Study 2 had a good fit to the data: $\chi^2 = 25.972$, $df = 18$, $p = .100$, CFI = .966, TLI = .933, RMSEA = .048, 95% CI [0.000, 0.085], and SRMR = .051. Similar to Study 1, and while controlling for gender, OP was positively associated with RP ($\beta = 0.41$, $p < 0.001$) and negatively with FP ($\beta = -0.25$, $p = 0.002$), whereas HP was positively associated with FP ($\beta = 0.46$, $p < 0.001$). Furthermore, self-reported science grades were positively associated to both FP ($\beta = 0.18$, $p = 0.012$) and RP ($\beta = 0.14$, $p < 0.001$) which in turn led to applications to STEM programs at university ($\beta = 0.34$, $p < 0.001$). Additionally, students who persisted flexibly were also able to experience wellbeing outside of school ($\beta = 0.23$, $p < 0.001$). As hypothesized, HP predicted involvement in science-related activities ($\beta = 0.30$, $p < 0.001$) which then also led to science grades ($\beta = 0.20$, $p = 0.002$). A significant direct link was observed between HP and wellbeing applications ($\beta = 0.16$, $p = 0.032$) (see Fig. 2).

[Insert Figure 2 here]

The significance of ten indirect effects was also tested using 500 bootstrap samples and the 95% bias-corrected confidence intervals (CIs) as suggested by Shrout & Bolger (2002). Our results confirmed the presence of eight significant indirect effects, providing support for the mediating role of persistence and extracurricular activities in the relationships between passion and academic and wellbeing outcomes. The standardized beta coefficients, *p* values, as well as 95% confidence intervals are shown in Table 5.

[Insert Table 5 here]

In summary, the results of Study 2 supported our hypothesized model in its majority. We replicated and extended the results of Study 1. First, as found in Study 1, HP was positively associated with flexible persistence, whereas OP was positively associated with rigid and negatively with flexible persistence. Second, both types of persistence were found to play a positive role in academic performance. Third, as hypothesized, only flexible persistence allowed one to experience positive outcomes outside of the school environment (i.e., psychological wellbeing), suggesting that rigidly persisting toward goals does not allow one to experience the fuller range of outcomes. Overall, passion for one's studies may yield positive academic outcomes if driven by both types of persistence, with only FP also leading to wellbeing.

Study 2 also reinforced the conclusions of recent studies focusing on the positive impact of participating in extracurricular activities (Denault & Guay, 2017; Denault & Poulin, 2017; Vandell et al., 2015). Our results moved beyond showing the effectiveness of extracurricular activities and extended this line of research by: (1) examining the relationship between involvement in scientific extracurricular activities and both types of passion and (2) how this relationship was indicative of academic performance. In line with previous studies demonstrating how participation in extracurricular activities was associated with higher academic achievement

(Dumais, 2009; Fredricks & Eccles, 2006, 2008; Lipscomb, 2007; Luthar et al., 2006), our findings replicated this relationship and provided empirical support for an additional mediator to both types of passion.

General Discussion

There were four goals to the present research. First, we sought to test the existence of two types of persistence, rigid and flexible, in the field of education. Second, we wanted to test the underlying role of HP and OP in the different types of persistence. Specifically, HP was expected to mainly lead to flexible persistence, whereas OP would mainly lead to rigid persistence and negatively to flexible persistence. Third, we wished to test the positive role of both types of persistence in academic outcomes. Fourth, we wanted to test the potential benefits of flexible over rigid persistence in outcomes outside the purview of the school environment (e.g., well-being) Finally, a fifth goal was to assess the mediating role of extracurricular activities in the relationship between passion and outcomes. The results of two studies provided support for these goals. In Study 1, HP and OP predicted rigid and flexible persistence which in turn positively predicted academic performance (grades). FP also positively predicted psychological wellbeing. Finally, grades positively predicted intentions to pursue a STEM program at university. Study 2 replicated the results in Study 1, but with actual STEM applications as an outcome. In addition, involvement in extracurricular scientific activities also positively predicted STEM grades. Overall, the results of the two studies provided strong support for the above goals and lead to a number of implications.

On the Qualitative Aspect of Persistence

In light of these two studies, it appears that two forms of persistence do exist, and they vary qualitatively depending on its nature, determinants, and consequences. Contrary to past

theory and research that mainly focused on the intensity dimension (low or high), the present perspective suggests that two types of persistence are posited to exist, namely flexible and rigid persistence. While both types of persistence may have high intensity as they are fueled by passion, the distinction between the two lies mainly in the quality of focus on the goals.

Indeed, results of Study 1 showed that a bi-factorial factorial structure depicting a flexible and rigid persistence was obtained. Also of importance, results of the SEM in both studies showed that the two types of persistence were empirically associated to HP and OP, thus fully confirming our hypotheses. Specifically, HP for science led to flexible persistence while OP led to rigid persistence, and negatively to flexible persistence. Finally, as expected, both types of persistence positively predicted academic outcomes, but only flexible persistence also led to positive outcomes outside of the school environment. These empirical findings on the nature, determinants, and outcomes of persistence emphasize the fact that there is evidence that two types of persistence exist. Further empirical studies are needed to provide support for the latter.

This conceptualization represents a new perspective on persistence in education. First, the distinction between the rigid versus flexible nature of persisting toward an educational goal is complementary to past conceptualizations that focus only on the intensity part of persistence. Although it is implicitly assumed that high intensity is key to successfully overcoming obstacles and reaching a desired goal, much less research has focused on the qualitative aspect of the persistence process. Although some authors have posited the importance of persisting in two ways in order to achieve a goal (Brandtstädter & Renner, 1990; Wrosch et al, 2003), such processes have typically pitched persistence toward the original goal versus scaling down or even letting go of that goal. The perspective that is advanced in the present research proposes that there are two ways to go about pursuing a given goal. The dual nature of rigid and flexible

persistence in the current study emphasizes the qualitative difference in how one keeps on persisting toward the same goal without changing it. This is different from previous conceptualizations, but complementary to past research and theory that focused on the intensity part of persistence. While both rigid and flexible persistence consider the intensity dimension, the novel contribution remains in the distinction between the rigidity versus flexibility nature of persisting. Rigid persistence leads students to focus solely on academic goals while experiencing positive outcomes. On the other hand, with flexible persistence, students can still achieve their educational goals, while also reaching other life goals. These hypotheses were upheld in the present research and are discussed below.

The Role of Rigid and Flexible Persistence in Educational and Life Outcomes

Previously, persistence in educational settings had almost exclusively been examined as a spectrum of continuation in a specific task or goal (Author 5; Hardre & Reeve, 2003; Kuh et al., 2008; Lavigne et al., 2007; Vansteenkiste et al., 2004). Research assessing persistence in relation to students' passion in academic settings is scarce, with one publication linking the two constructs in terms of activity engagement by means of deliberate practice (Bonneville-Roussy et al., 2011) and another examining how autonomy supportive learning environments are associated with a HP and with high persistence in a chosen field of study (Bonneville-Roussy et al., 2013).

The present findings emphasize the role of persistence as a process that yields positive outcomes within a specific context. This was found in the present research with both Studies 1 and 2. Specifically, both types of persistence led to school-related outcomes such as academic performance, intentions to pursue in STEM, and applications to STEM programs. Similar findings have been obtained advocating how the two types of passion contribute similarly to behavioral outcomes such as deliberate practice and objective and informant reports of

performance (e.g., Bonneville-Roussy et al., 2011; Bonneville-Roussy et al., 2013). Future research on this issue is necessary with respect to the role of flexible and rigid performance in a variety of outcomes, including experiential and behavioral outcomes (Author 10).

There is a general tendency to believe that rigid persistence may be necessary to reach high levels of performance or achievement, even sometimes at the expense of other important goals. Our findings from Studies 1 and 2 demonstrated that this was not always the case. In addition to performing well, students who persisted flexibly also experienced positive outcomes outside of school (e.g., psychological well-being) given that it had a broader focus compared to rigid persistence. This raises doubts whether or not a rigid persistence is the only way to reach high performance. Future research is necessary to more firmly support this particular claim on persistence.

On the Role of Passion in Persistence

The present research provides further support for the DMP and posits that both types of persistence take origin in the two distinct forms of passion. Specifically, under the DMP, flexible persistence originated in HP, while OP was mainly conducive to rigid persistence. This major hypothesis was upheld in both studies implying that how one engages in a passionate activity will determine the qualitative aspect of the way they persist.

This study is also the first to show the existence of two types of persistence, rigid and flexible, in an educational context and to chart their determinants and outcomes. The results of the SEM in Studies 1 and 2 provided support for the latter and presented a novel model in which we study persistence as a process, and not an outcome as has often been the case in past educational research.

These findings are in line with other passion-based studies (e.g., Bélanger et al., 2019;

Philippe et al., 2017) showing how, unlike HP, individuals with OP engage in an activity with a unidimensional perspective and dismiss other life goals. This was further demonstrated in our studies by the negative relationship that existed between OP and flexible persistence. Given past research showing how OP leads to conflict between activities taking place in different contexts (e.g., personal vs. professional) (Author 9; Boiché & Caudroit, 2019), it was expected to undermine a flexible persistence toward a goal. This hypothesis was not supported in both our studies.

Practical Implications

Cultivating persistence in education is not an easy task and certainly not something that should be underestimated. Persisting in challenging academic situations is quite demanding! Although the present research was exploratory given the new persistence scale, the outcomes from these studies provide us with potential applications in the education field. Research on the determinants and outcomes of passion provides us with some blueprints of the potential applications that can be used to promote HP and flexible persistence in classrooms. For example, teachers could encourage students to pursue different activities that they are passionate about and then encourage them to reflect on their experiences by expressing their emotions. Investigating if such activities triggered some excitement and enthusiasm can eventually guide teachers to plan for lessons related to such activities. Additionally, teachers who create a positive learning environment through their instructional approach also foster HP and, ultimately, persistence toward positive learning outcomes (Ruiz-Alfonso & León, 2019). This is important because creating a supportive classroom structure where pressure and ego-involvement are minimized, is a way of facilitating HP. Thus, captivating presentations combined with tasks that are content relevant lay the foundations for promoting HP and a flexible persistence in education.

Another area to apply the knowledge gained from these two studies is in that nuance where going to school is significantly different than just attending class. In this vein, we can nurture the development of HP among our students by engaging them in extracurricular activities that they are passionate whether that takes place during recess, lunchtime, or after school (Fredricks et al., 2010). A good example of the latter is portrayed in specialized schools that offer sports-study programs (Author 8) or other streamed programs (e.g., arts, dance, music, robotics). Such schools play a crucial role in allowing students to fully experience the activity they are passionate about, while also developing specialized friendships (Author 8) and persisting flexibly in some of their preferred academic subjects (Lafrenière et al., 2007).

Finally, we also wish to suggest that these findings also have implications for professional development, especially for novice teachers who too often tend to leave the profession prematurely because of the unfavorable conditions they experience (Luft, 2009). We need to create the conditions that keep alive our teachers' passion for teaching. Teachers should be able to teach the subjects that they love and that have been trained in while having the necessary resources to deal with the demands that they face. It seems dysfunctional and not conducive to the development of a passion to assign incoming teachers with more difficult classrooms while seasoned teachers manage the less disruptive ones (Author 7).

Limitations and Suggestions of Future Research

The present studies show some limitations and, therefore, their findings should be interpreted accordingly. First, all measures were self-reported and consequently may have inflated the covariance between certain variables. Although, we did visit classrooms in-person to collect the data, it would nevertheless be important to replicate these studies with other types of measures such as informants and objective performance records. Second, because the

measurement of persistence in this dual fashion is new and is in an exploratory phase, the variable nature of personal conceptions may have influenced the way participants responded to this scale. It would be helpful to search for other complimentary means to measure how individuals could objectively indicate the degree of flexible vs. rigid persistence.

Third, the present research only relied on correlational designs and, therefore, cannot make inferences of causality. In line with past passion research, future research should randomly assign students to experimental conditions of HP and OP in order to ascertain the causal role of passion in persistence (e.g., Bélanger et al., 2013). Finally, the participants were part of a competitive academic program (e.g., science) which required a stringent incoming high school average as an admission requirement. Thus, these students may not be representative of the overall student population. Additional research is necessary to replicate these findings with different students in educational contexts while using longitudinal and experimental designs.

Future research would be necessary to replicate the present results over an extended period of time and with a variety of educational contexts and students at different levels. For instance, the present research has not yet examined any negative outcomes in education. In what situations, if any, would rigid persistence lead to negative outcomes? Past findings have shown that, contrary to HP, OP leads to negative affect, addiction, and burnout to name a few. To what extent can rigid persistence also be conducive to such detrimental effects in an educational context? Similarly, under what conditions would flexible persistence be less adaptive and fail to reach outcomes outside a specific context? Longitudinal research and diary studies can contribute to a better understanding of how with passion one can achieve goals with a rigid or flexible persistence. Future research on these and other issues within the context of persistence would appear to be important.

Future educational research is also necessary to better understand whether rigid persistence is used regularly by students toward the completion of a goal or if it is used sporadically from time to time depending on external or social conditions. To what extent are OP and HP experienced at different degrees for students in various programs and educational levels? What is the long-term impact of rigid persistence on school and life outcomes for those with a predominant OP? Using a quadripartite approach to the DMP (Schellenberg et al., 2019) would indicate if it is possible to hold both forms of passion and adopt both forms of persistence simultaneously. In a similar vein, it would also be possible to determine the consequences for academic performance, continued pursuit of STEM, and psychological well-being if both forms of passion are held and students selectively adopt both forms of persistence. These questions and hypotheses deserve merit in future educational research.

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Figure 1

Study 1-Passion, Persistence, and Outcomes

Note. * = $p < .05$, ** = $p < .01$, *** = $p < .001$. Gender: Male = 1; Female = 2
Chi-sq = 32.138, df = 12 $p < .05$, CFI = .961, TLI = .908, RMSEA = .053 [.032, .076], SRMR = .037, N = 591

Figure 2

Study 2-Passion, Persistence, and Outcomes

Note. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Chi-sq = 25.972, df = 18, $p = .100$, CFI = .966, TLI = .933, RMSEA = .048, SRMR = .051, N = 198

Table 1

Measurement Invariance Fit Indices on the Persistence Scale

Model	X ²	df	CFI	RMSEA	SRMR	ΔCFI
Overall	31.197	8	.953	.070	.032	
Males	15.340	8	.955	.063	.044	
Females	28.521	8	.939	.085	.040	
Configural	43.861	16	.944	.077	.042	
Metric	49.087	20	.942	.070	.045	.002
Scalar	51.583	24	.945	.063	.047	.003
Means	56.803	26	.938	.064	.052	.006

Table 2

Means, Standard Deviations, and Correlations for Study 1

	Mean (SD)	OP	HP	RP	FP	AcdPf	WB
OP	2.18(0.77)	--					
HP	3.30(0.80)	.44***	--				
RP	2.83(0.90)	.39***	.24***	--			
FP	4.02(0.72)	-.06	.31***	-.05	--		
AcdPf	5.97(1.65)	.10*	.26***	.13**	.16***	--	
WB	3.49(0.87)	.08*	.26***	.11**	.19***	.22***	--
Int	4.34(0.99)	.28***	.25***	.28***	.01	.20***	.18***
OP: Obsessive Passion		RP: Rigid Persistence		AcdPf: Academic Performance			
HP: Harmonious Passion		FP: Flexible Persistence		WB: Wellbeing		Int: Intentions	

Table 3

Study 1-Indirect Effects from Passion to Outcomes

Harmonious Passion to Outcome		Indirect Effect	<i>p</i>	95% CI	
Mediator				Lower	Upper
Academic Performance	FP	0.061	0.000	0.082	0.170
Wellbeing	FP	0.054	0.005	0.017	0.099
Intentions	FP→AcdPf	0.022	0.001	0.013	0.048
Obsessive Passion to Outcome		Indirect Effect	<i>p</i>	95% CI	
Mediator				Lower	Upper
Academic Performance	RP	0.032	0.030	0.007	0.129
Intentions	RP	0.069	0.000	0.040	0.137
Wellbeing	FP	-0.031	0.008	-0.060	-0.009
Intentions	RP→AcdPf	0.005	0.053	-0.000	0.013
Intentions	FP→AcdPf	0.009	0.001	0.004	0.019

Table 4

Means, Standard Deviations, and Correlations for Study 2

	Mean (SD)	OP	HP	RP	FP	ExAct	AcdPf	WB
OP	2.24(0.84)	--						
HP	3.29(0.83)	.61***	--					
RP	2.74(0.90)	.41***	.32***	--				
FP	3.89(0.79)	.03	.31***	.07	--			
ExAct	1.41(0.49)	.12	.30***	.13	.15*	--		
AcdPf	5.96(1.51)	.09	.23**	.09	.22**	.25***	--	
WB	3.56(0.86)	.08	.22**	.22**	.33***	.07	.12	--
App	2.08(1.29)	.04	.17*	.05	.13	.18*	.33***	-.02
<i>OP: Obsessive Passion</i>		<i>RP: Rigid Persistence</i>			<i>AcdPf: Academic Performance</i>			
<i>HP: Harmonious Passion</i>		<i>FP: Flexible Persistence</i>			<i>WB: Wellbeing</i>			
<i>ExAct: Extracurricular Activities (1=No; 2=Yes)</i>					<i>App: Applications to university</i>			

Table 5

Study 2-Indirect Effects from Passion to Outcomes

Harmonious Passion to Outcome		Indirect Effect	<i>p</i>	95% CI	
	Mediator			Lower	Upper
Academic Performance	FP	0.081	0.026	0.018	0.279
Academic Performance	ExAct	0.061	0.015	0.022	0.203
Wellbeing	FP	0.066	0.002	0.040	0.172
Science App	FP→AcdPf	0.027	0.043	0.001	0.084
Science App	ExAct→AcdPf	0.021	0.031	0.003	0.061

Obsessive Passion to Outcome		Indirect Effect	<i>p</i>	95% CI	
	Mediator			Lower	Upper
Academic Performance	RP	0.059	0.001	0.042	0.171
Academic Performance	FP	-0.043	0.062	-0.159	0.004
Wellbeing	FP	-0.035	0.013	-0.012	-0.055
Science App	RP→AcdPf	0.020	0.007	0.008	0.053
Science App	FP→AcdPf	-0.015	0.076	-0.047	0.002