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Academic self perceptions in a national Danish sample: Predictive power and development from grade 4 to 9

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ABSTRACT

Research on students' understandings of their academic performance often faces limits with respect to sample diversity, statistical power, breadth of participant information, and ability to continuously track the development of participants. Government registry data do not face such limitations. We validate a brief measure of academic self-perceptions contained within the Danish Well-Being Survey, a self-report measure administered annually to all Danish public-school students (grades 4 through 9) and linked with rich registry data regarding these students, their families, schools, and communities. We then perform exceptionally well-powered analyses of the influence of academic self-perceptions on the pursuit of further academically-intensive education ($N = 35,227$) and of the development of academic self-perceptions during late childhood and adolescence ($N = 284,024$).

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1. Introduction

Individual's assessments of their personal competences and capabilities are highly consequential, with a substantial body of literature demonstrating the importance of such self-assessments particularly in the academic domain (Marsh, Martin, Yeung, & Craven, 2018). Befitting the decades of research devoted to these academic self-perceptions (ASP), researchers have utilized a diverse range of often powerful and diverse samples (e.g., Cole et al., 2001; Harter, 1982; Marsh, 1989; Wigfield et al., 1991).

This work can be powerfully supplemented via the incorporation of a sample type that is (to our knowledge) yet to be included in any study of ASP or closely-related constructs, namely government registry data. Government registries typically maintain continuously-updated information on a highly diverse range of characteristics and outcomes. The Danish registries described in the present research not only include academic data such as exam performance, attendance, and attainment, but also information on domains such as occupational status, tax and other financial data, mental and physical health, and even legal troubles (Jensen & Rasmussen, 2011; Pedersen, 2011). Further, government registries

are able to avoid many limitations with respect to attrition, self-selection, homogeneous samples, and low statistical power. Given this, newly acquiring the ability to study any psychological construct within such a registry represents a highly noteworthy expansion upon previous research opportunities.

With the present work we therefore seek to provide an initial validation and exploration of an abbreviated assessment of ASP newly provided in the Danish registries, available to all researchers who acquire approval from the Danish government. The validation analyses include comparing ASP scores against academic performance assessed via computerized adaptive tests as well as with a self-report survey of a closely related construct, namely academic self-efficacy (Muris, 2001). We then demonstrate the power of these data by showing that the short ASP assessment has substantial predictive validity for subsequent selection into advanced educational tracks. We also explore the development of ASP during the sensitive years of late childhood and early adolescence. Reflecting the strengths of registry data, these appear to be the most thoroughly powered exploration of either topic yet conducted.

1.1. The Danish Well-Being Survey

Given the rich data available in Danish (and other) government registries, it is unsurprising that the information from these administrative data has been widely exploited by some corners

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of social science, such as economics. Psychological research using registries is, by contrast, distinctly sparse. This may reflect psychology’s reliance on self-report surveys, a form of data that is less commonly included within government registries. Consistent with this, many psychological studies using registry data simply link conventional self-report surveys collected independently (i.e., outside of government registries) with existing government registry data (e.g., Petersen & Aarøe, 2015; Von Soest et al., 2016). However, such studies often face limitations typical to non-registry research, such as restricted statistical power, low response rates, and an absence of rich longitudinal data on the characteristics in question. Given these considerations, it would seem that when a government registry introduces its own conventional self-report assessment of common psychological characteristics that a particularly striking opportunity for psychological researchers arises.

Just such a valuable combination of registries with self-report data has recently developed, when the Danish government introduced the Danish Well-Being Survey (DWS). This survey is administered annually to all public-school classrooms up to grade 9, though with a limited form with different items and responses administered to those in grades 0 to 3. Students complete the survey in the school’s computer room, logging in via their student identifier, which is in turn linked within the Danish registries to their Danish social security number.

Despite the obvious limitations of instruments such as DWS that are designed to address multiple objectives with a limited number of items (Andersen et al., 2015), validation work has supported the use of DWS measures of personality traits such as Conscientiousness, Agreeableness, and Neuroticism (Andersen et al., 2020), and research has productively explored associations between DWS data and family background (Loft & Waldfogel, 2020; Ludeke et al., 2020).

1.2. Expectations for ASP in the DWS

The two items used in the present ASP measure are “I am doing well in school work” and “I am making good academic progress in school.”² These items point to some uncertainty concerning the most appropriate construct name. Most notably, items such as these are commonly included in measures of Academic Self-Concept (ASC; e.g., Marsh & O’Neill, 1984; Preckel et al., 2013; Reynolds, 1988). However, because ASC measures often include questions beyond those simply evaluating one’s academic performance and progress (e.g., pertaining to academic interests), some researchers may object to labelling a measure based exclusively on these two items as representing ASC, and for this reason we instead refer to the construct reflected in the DWS items as ASP. At the same time, because items similar to the two items in question represent a substantial portion of many ASC measures, results based on ASC measures are likely to be highly informative for results using our narrower measure.

We have the following expectations—none of which were pre-registered due to our reliance on secondary data collected for other purposes—for our analyses of ASP in the Danish registry data:

- (1) *Coherence of the item content:* The two items used to assess ASP should strongly correlate with each other, as would be expected if the items represented a coherent construct.
- (2) *Convergent validity:* ASP should correlate highly with pilot study data from the Academic subscale from the Self-Efficacy Questionnaire for Children (SEQ-C; Muris, 2001), given previous findings that ASC correlates very tightly with academic self-efficacy (Lent et al., 1997).

- (3) *Criterion validity:* ASP should exhibit strong correlations with actual academic performance, matching what Harter (1982) found with the very similar Cognitive domain of her Perceived Competence Scale for Children, and matching results from Youth in Transition data (Marsh & O’Mara, 2008).
- (4) *Predictive validity:* ASP should positively predict enrollment in advanced education, even after controlling for academic performance (Guo et al., 2015; Marsh & O’Mara, 2008).

Beyond testing these hypotheses, we will also evaluate the development of ASP scores. Previous research suggests these should decline through much of the developmental period studied here (Jacobs et al., 2002; Marsh et al., 2005), though the precise shape of that decline—including the age it begins, the age it ends, and whether we will already see evidence of a rebound by the oldest segment of our sample (grade 9)—is perhaps less certain. This uncertainty reflects in part questions of the role of school transitions: Some authors have suggested that developmental changes in related constructs during these ages represent the effects of school transitions (e.g., to junior high school; Wigfield et al., 1991), and Denmark lacks such a differentiation between elementary and middle school. In addition to providing information on the development of ASP, then, this data can also evaluate the putative roll of such school changes in any observed development in ASP.

With these analyses, we expect to show that the ASP data contained within the DWS is worthy of further use in future research.

2. Method

2.1. Samples

2.1.1. Primary Sample: Registry analyses

The present study primarily relies on data collected by the Danish government for administrative purposes. Permissions for the data and monitoring concerning its ethical and legal use is obtained by registering the project with the Danish Data Protection Agency (registration no. 2016-051-000001), which supervises compliance with rules regarding the protection of personal data. Table 1 presents the details concerning participant numbers and where participants are lost due to missing data, and shows that we have between 35,227 and 284,024 participants available for our various analyses performed on this sample. This provides essentially 100% power to detect associations of a socially-significant magnitude. Relatedly, unless otherwise specified, all results are $p < .001$.

2.1.2. High school survey sample

For one analysis (the correlation between academic self-evaluations and scores on the SEQ-C) we use data from a survey of Danish high school students completed in May of 2016, described by Andersen et al. (2017). All Danish high schools were

Table 1
Breakdown of Participant Data Loss in Registry Data Analyses.

	N	
	2016	2017
Public school students enrolled in grades 4–9	294,227	287,735
...with complete Academic Self-Perceptions data	284,024	277,058
...enrolled in Grade 9	41,080	38,959
...with complete Exit Exam performance data	35,238	NA
...with High School enrollment decision data	35,227	NA

Note. Ns for a lower-listed condition are always subsets of the Ns listed immediately above, given that analyses using the lower-listed data also required all data listed above. Exit Exam and High School Enrollment data was not available to us for 2017 at time of writing.

² Free translation from the Danish wording, which is “Jeg klarer mig godt fagligt i skolen” and “Jeg gør gode faglige fremskridt i skolen.”

invited to participate in the survey, with 48 schools accepting. Students were randomly assigned to complete different blocks of items, such that 3550 students completed all of the items needed for this analysis.

2.2. Measures

2.2.1. Academic self perceptions

Students complete these items as part of the DWS, which was completed during the school day in the school's computer room. Participation of schools was mandatory, though individual students may not have responded due to absenteeism on the day of the survey or failing to respond to individual items. Students logged on to the digital survey instrument with their student identifier, which is linked to the Danish social security number. This allowed us to link their survey responses to other administrative data, including their test scores and high school enrollment choices.

The items we used to measure ASP in the DWS were completed on a 5-point Likert scale ("Completely disagree," "disagree," "Neither agree nor disagree," "Agree," "Completely Agree"). Despite average responses above the mid-point of 3, each item retained substantial variability ("I am doing well in school work" has $M = 3.9$ and $SD = 0.81$ in both 2016 and 2017; "I am making good academic progress in school," $M = 3.9$ (3.8) and $SD = 0.78$ (0.78) in 2016 (2017)).

For analyses performed below, each item was normalized to mean 0 and standard deviation 1. They were then aggregated as a simple mean and re-normalized within the analysis sample. Below we use scores from the 2016 and, for an immediate replication, 2017 DWS assessments.

ASP data was also collected from the High School Survey Sample, using the same items and response format.

2.2.2. SEQ-C

Participants in the high school survey sample completed a Danish translation of the full 8-item SEQ-C Academic scale (Muris, 2001), which uses items like "How well do you succeed in passing all subjects" to assess academic self-efficacy. The five scored response categories ran from "Very good" to "Poor," with a sixth response ("Do not wish to answer") coded as missing. The SEQ-C was highly reliable ($\alpha = 0.81$).

2.2.3. Academic performance

Danish students complete exit exams at the end of 9th grade. Four subjects (comprising a total of eight exams) are compulsory. Analyzing only students with data on all eight compulsory exams, we form the average score and then standardize. These exams are three written and one oral examinations in Danish, two written examinations in mathematics, and oral examinations in English and science/chemistry. A pair of evaluators for each exam gives a grade on a 7-point scale. The student's teacher serves as one of these evaluators for oral examinations (alongside an external examiner). For written exams, the student's teacher has no role in the grading process. We averaged and normalized exam scores to mean 0 and standard deviation 1. Correlations among individual the exam scores ranged from 0.35 (between Danish written essay and science/chemistry) to 0.79 (two written Math exams) and Cronbach's alpha was 0.88.

2.2.4. Academic choice outcome

The Danish educational system offers students several options for upper secondary education after the completion of compulsory schooling with 9th grade. These options include vocational programs as well as the more academically-intensive high school ("gymnasium"), the latter of which prepares students for

university education. We dichotomize the available choices into an indicator of academic high school immediately following 9th grade versus the other less academically ambitious alternatives. Only 40% of 9th graders in 2016 chose to continue immediately to academic high school. (Data was not available to us at the time of writing for choice after 2017.)

3. Results

3.1. Initial validation analyses

To evaluate the sensibility of creating a two-item composite we first explored how the two academic self-perception items correlated with each other. The items appear to be quite coherent, correlating 0.68 [95% CI: 0.67 to 0.68] with each other in 2016 (2017: $r = 0.69$ [0.68 to 0.69]).

To examine convergent validity we then obtained the correlation between ASP and the SEQ-C Academic scale (Muris, 2001) in the high school survey sample. Consistent with prior findings and demonstrating the tight linkages between these constructs, the correlation was very high ($r = 0.69$), particularly noteworthy given the brevity of the ASP measure.

Finally, to examine criterion validity we correlated children's self-perceptions with their actual academic performance. Among the 35,227 9th graders with data for the exit exam composite and ASP, the correlation between the two was 0.48 [0.47, 0.49].

3.2. Predicting academic choice

We next predicted subsequent school choice among 9th graders from 2016, evaluating whether ASP would predict enrollment in an academically more or less demanding course of subsequent education. Using a probit regression for 9th graders from 2016, we found a 1 SD increase in ASP predicted a 16.1 [15.7, 16.6] percentage point increase in the likelihood in enrolling in academic high school. Of course, ASP is substantially related to exit exams, which is itself a substantial predictor of enrolling in academic high school: A 1 SD increase in exit exams predicted a 18.2 [17.8, 18.6] percentage point increase in the likelihood of enrolling in academic high school. However, even when considered simultaneously as predictors in a multiple regression, ASP retains a substantial independent contribution, with a 1 SD increase predicting a 9.2 percentage point [8.7, 9.8] increase in high school enrollment over and above the attendance probability indicated by the exit exams. The impact of exit exams on high school enrollment (=13.8, [13.3, 14.3]) also remains potent.

The effect of ASP on high school enrollment was not, however, universal. Fig. 1 shows how the predicted probability of enrollment in academic high school varied based on the exit exam performance of the student. Among high performing students, ASP had very little effect on high school enrollment, and a much larger effect on lower performing students. Importantly, this does not appear to reflect censoring: Even among the quantile of students with the highest exit exam scores, more than 70% of the students had ASP raw scores below the maximum (an average response of "5"), and a third of this quantile scored "4" (indicating, e.g., "agree" rather than "completely agree" for both items).

3.3. Changes across development

Fig. 2 shows how ASP scores differed across grades 4 through 9. ASP scores from 2016, broken down by grade, are connected by the continuous grey line. ASP scores were at their highest among the 4th and 5th graders, their lowest level among 8th graders (who score more than a quarter of a SD lower than their grade 4/5

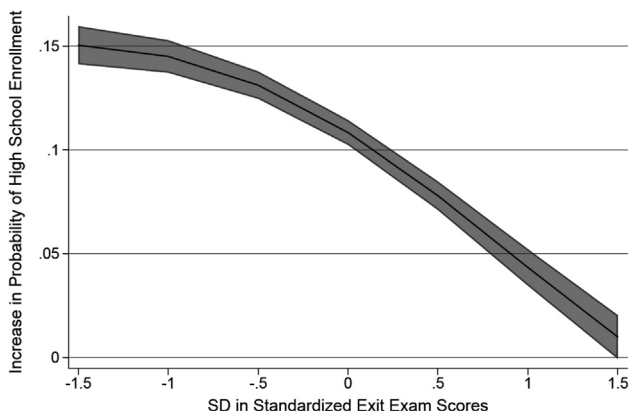


Fig. 1. Effect of ASP on Probability of High School Enrollment is Moderated by Academic Performance. Note. Y axis represents percentage point increase in high school enrollment probability associated with +1 SD in Academic Self Perceptions (ASP). Results are from 2016 sample ($N = 35,227$), with 95% CIs and point estimates shown.

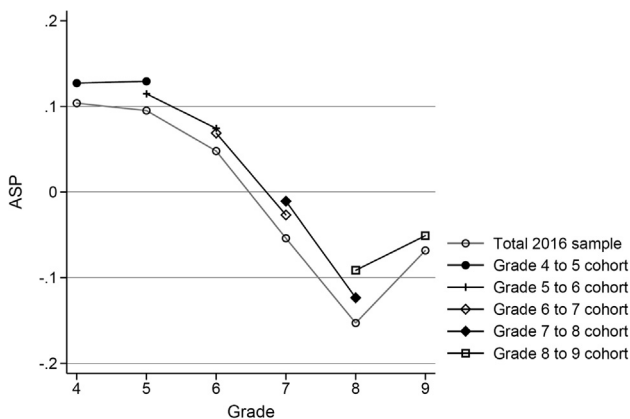


Fig. 2. Changes in Academic Self-Perceptions between Grades 4 and 9. Note. Academic Self-Perception (ASP) scores were standardized across the entire sample. Between grades 5 and 9, mean ASP scores significantly change each year ($p < .001$).

counterparts), with scores among 9th graders seeming to indicate some recovery from the grade 8 trough. Between grades 5 and 9, mean ASP scores significantly change each year ($p < .001$).

Figure 2 also presents two-year panel data from five separate cohorts, enabling us to examine if these cross-sectional grade differences are plausibly attributable to developmental patterns rather than cohort effects. These cohorts are defined by their 2016 grade (one cohort each for grades 4 through 8), with results presented only for participants with data in both 2016 and 2017. Longitudinal results from each panel closely parallel the cross-sectional results from 2016. However, two differences between the panel and cross-sectional results bear note.

First, panel ASP scores are somewhat higher (a few hundredths of a standard deviation) than are the cross-sectional ASP scores in any given year. This is not surprising: Previous research has found that missing data on the DWS (whether through absence or not responding to an item) is linked with poor academic performance (Andersen et al., 2020). Students with data available on DWS in both years rather than just in 2016 should thus be expected to be more academically capable, and given the tight link we have observed between academic performance and ASP, ASP scores should accordingly be slightly higher among those represented in both years of the DWS (i.e., in the longitudinal two-year cohorts) than in the slightly more inclusive/larger 2016 sample.

The second divergence of note is that grade 8 scores differ noticeably between the two cohorts. Relatedly, whereas the transition from grade 7 to 8 looks very similar in both the cross-section and panel results, the ASP improvement shown in transition from 8 to 9 is half as steep in the longitudinal panel results as in the cross-sectional comparison. We suggest this discrepancy reflects somewhat misleading results in the cross-sectional analyses. A number of students leave the public school system after grade 8 and start grade 9 at private schools or boarding schools that don't mandate completion of the DWS (Statistics Denmark, 2014). Such students tend to have somewhat lower academic performance, which is why 8th grade ASP scores are higher in the cohort of students that has remained in public schools after this window (i.e., the 8–9 cohort) than in the cohort that has yet to face this winnowing process (i.e., the 7–8 cohort). The cross-sectional results thus exaggerate the ASP improvement expected in the transition to 9th grade due to the comparatively elevated attrition of low-ASP students out of the sample after 8th grade. Nevertheless, the cross-sectional results accurately represent the general developmental trend in ASP scores, including the early-adolescent decline and the late-adolescent recovery. Given the absence of any routine school changes during this period (such as a shift to high schools), these results contradict strong claims to a predominant role for such educational transitions in influencing age trends in ASP (contra Wigfield et al., 1991).

4. Discussion

We sought to both demonstrate the utility of the brief ASP measure contained within the DWS and to provide initial demonstrations of the power of the available data.

4.1. Subjective Self-Perceptions are important

The ASP items were tightly connected to each other and showed both convergent and criterion validity, namely substantial associations with a closely-related construct (academic self-efficacy) and with an objective measure of academic performance. Most important, ASP was substantially connected to a life outcome of tremendous importance, namely high school enrollment. In a multiple regression, ASP predicted immediate enrollment in a more academically rigorous high school even after controlling for actual performance and did so with an effect size fully two-thirds as large as actual academic performance. This academic outcome is an important one, as it is linked to lifetime earnings: Individuals who do not progress to academic high school earn markedly less than do those who do (Danmarks Statistik, 2013). Because other important life outcomes (whether in the academic, occupational, health, family, or legal sphere) represent an area that registry data provides better than any other conventional data source, the ready availability of data from a measure as salient as ASP should be of great interest to researchers.

4.2. Academic Self-Perceptions change from late childhood to adolescence

We observed systematic changes in ASP scores through development, with the lowest scores (observed in 8th grade) a quarter of a standard deviation below the highest scores (observed in grade 4). It is noteworthy that this decline occurred despite the absence of any changes in school settings. Whereas an influential study by Wigfield et al. (1991) attributed similar declines in ASP to the transition to junior high (or middle) school, Denmark has no such change in school settings during the time window we studied. These results thus suggest the search for more endogenous sources

of change in ASP. More generally, the current validation of ASP in a very large and continuously updated government dataset opens up possibilities for considerable future research into antecedents and consequences of ASP throughout development.

4.3. Limitations and generalizability

As briefly noted in the introduction, DWS measures have important limitations that must be kept in mind. Brevity is a concern: With only two items, links between ASP and outcomes may be attenuated (Credé et al., 2012). However, measures of related and ostensibly broader constructs like ASC are occasionally measured with comparable brevity (e.g., three items in Preckel et al., 2013) without obvious problems. Further, previous work with other DWS scales has produced astonishingly replicable results even from two and three-item scales (Andersen et al., 2020), speaking against concerns that the DWS ASP measure is dominated by statistical noise. One potential contributor to that replicability is the fact that the DWS is completed by the overwhelming majority of public school students, ranging across an impressively full diversity of ability levels and backgrounds (Andersen et al., 2020). Even brief measures from DWS data thus likely enjoy compensatory benefits such as lower-than-typical attenuation attributable to restricted range.

Another salient characteristic of the ASP in the DWS also applies to many non-DWS measures of ASP and related constructs (e.g., Harter, 1982; Preckel et al., 2013), namely that rather than balancing between protrait and contrait items, both ASP items are protrait. This may increase problems deriving from response styles (Paulhus, 1991). However, the strong results concerning criterion and predictive validity, both with non-self-report measures, indicate this did not overly affect the DWS ASP measure.

More distinctively, whereas assessments of ASP and related constructs sometimes (though not universally: e.g., Harter, 1982; Marsh & O'Neill, 1984; Preckel et al., 2013; Reynolds, 1988) focus exclusively on evaluations within a given domain of academic performance (e.g., mathematics), the ASP items included in the DWS refer to academics in general. While we found performance on various exit exams to be highly correlated, these correlations were far from perfect, such that a given student's performance will sometimes be quite different in different subjects. This presumably attenuated the association between DWS ASP and academic performance, relative to what would be observed with subject-specific ASP measures.

Some potential constraints on generalizability follow from prior work and basic practical considerations. For example, because personality items have been observed to show exhibit substantially weaker intercorrelations outside of developed Western countries (Ludeke & Larsen, 2017; Weinschenk, 2017), the very high intercorrelations of our ASP items may be attenuated in other contexts. Further, the pronounced effect we observed for ASP on further education may well be affected by location-specific details of that education, such as how access to that education is determined (e.g., considerations of cost and meritocracy) and what proportion of a society pursues such further education. Enrollment in Danish high school (which is free, meritocratic, and which many students choose not to pursue) plausibly represents a context in which ASP would be comparatively influential. Other relevant constraints on generalizability may be identified as future work expands on the present exploration of ASP as measured by the DWS.

CRedit authorship contribution statement

Miriam Gensowski: Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review

& editing. **Steven G. Ludeke:** Conceptualization, Methodology, Project administration, Writing - original draft, Writing - review & editing. **Oliver P. John:** Conceptualization, Writing - review & editing. **Simon Calmar Andersen:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Resources, Visualization, Writing - review & editing.

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