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Learning for at-risk students. A dynamic perspective

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Florian Schmiedek

Learning for at-risk students

A dynamic perspective

In recent years, there has been growing concern about the socio-emotional well-being and mental health of children and adolescents. These concerns add to the ongoing concerns about the academic achievement of these age groups, particularly with regard to basic competencies, and especially for children from disadvantaged backgrounds. For an education system that not only aims to promote the development of such competencies, but also takes responsibility as an important environment for the identification and prevention of mental health problems and the general improvement of socio-emotional well-being, the question arises as to how these two general domains of outcomes are related. Are they positively intertwined, such that promoting one domain will automatically benefit the other – and failing to do so will increase risk in the other? Or are these outcome domains in conflict, requiring decisions about how to allocate limited educational resources? In what follows, I will argue that attempts to answer these questions at a general level are limited. Rather, the dynamic processes that link learning and well-being and that may place learners at risk for academic failure and mental health problems should be understood as potentially highly individualized and therefore deserving of investigation from a within-person perspective that takes this individuality into account.

1 Students at risk for academic failure and mental health problems

Since the sobering results of the first PISA studies, there has been increased monitoring of the educational system, resulting in worrying figures on the prevalence of students at risk of academic failure. For example, there are the large and increasing percentages of students failing to meet minimum standards in basic competencies as documented by the IQB Bildungstrend (Stanat et al., 2023) and similarly concerning trends in the number of students dropping out of school, as reported in the most recent National Report on Education (Autor:innengruppe Bildungsberichterstattung, 2024). Asking about the risk factors that in turn predict such indicators of academic failure, there is strong empirical evidence for general (background or distal) factors like, for

example, poverty (Selvitopu & Kaya, 2023) and migration background (Heath & Brinbaum, 2014). These contribute to more proximal risk factors at the level of the individual student, like lack of language competences (Snowling et al., 2021), socio-emotional competences (McLeod & Kaiser, 2004), or self-regulation competences (Robson et al., 2020). If the expression of such individual factors is pronounced, it can lead to fulfilling the diagnostic criteria for high-risk categories such as learning disorders or attention deficit hyperactivity disorder (Caviola et al., 2024).

With regard to socio-emotional well-being, there is growing evidence of a disturbingly high and increasing prevalence of mental health problems among children and adolescents. Reports by both international (McGorry et al., 2024) and national expert commissions (Deutsche Akademie der Naturforscher Leopoldina, 2024) have recently reviewed the empirical literature and noticed the magnitude and urgency of the problem. Among the most important risk factors for mental health problems, again background factors such as poverty (Klasen et al., 2017) are prominent. As more proximal factors, familial factors (e.g., mental health problems of parents; Beardslee et al., 2011), experience of violence and abuse (Baldwin et al., 2023), and mobbing (Duffy & Sperry, 2012), for example show relevant roles in predicting mental health problems, which can manifest in diagnoses of mental disorders in the extreme case. In children and adolescents, the disorder categories of depression, anxiety, and psychosomatic problems are particularly prevalent (Deutsche Akademie der Naturforscher Leopoldina, 2024).

In summary, the current numbers and longitudinal trends in both domains, academic achievement vs. failure and socio-emotional well-being vs. mental health problems, are alarming and call for increased political and societal efforts to address and reduce these problems. The fact that important risk factors for both problem domains are partly the same may lead to the expectation that there should be a positive relationship between both problem domains. So, what is the scientific evidence for such an association?

2. The relation of academic achievement and well-being: Theoretical arguments and empirical findings

Regarding theoretical considerations, one can find arguments for, both, a positive ("win-win") relation, as well as a negative ("trade-off") relation between academic achievement and well-being. Arguments for a positive relation often posit positive reciprocal effects between both domains. For example, the *Broaden-and-Build Theory* (Fredrickson, 2001) proposes that well-being can

foster learning processes through a broadening of thought-action repertoires, which can allow to build personal resources that, in turn, enhance well-being. *Self-determination theory* (Ryan & Deci, 2000) also assumes reciprocal relations, with academic success satisfying the need for competence. Being one of the basic psychological needs according to this theory, its satisfaction contributes to well-being. Furthermore, it serves a basis for the development of intrinsic motivation, which in turn is again beneficial for academic performance. Reciprocal effects are also central to *Developmental Cascades Theory* (Moilanen et al., 2010), which posits that externalizing and internalizing symptoms and academic failure can mutually enhance each other.

However, arguments can also be found for a negative relationship between the two domains (see Högberg, 2023, for a summary). The simple fact that time is limited potentially leads to opportunity costs: students who invest a lot of time in learning have less time left for other (e.g., leisure and social) activities that are beneficial for their socio-emotional well-being. In addition, high-achieving contexts (such as elite schools) are often characterized by a competitive climate and a disproportionate emphasis on performance, which can have negative emotional consequences. Given that these different theoretical mechanisms may all contribute to the overall relationship between academic achievement and well-being and thus (partially) counteract each other, it is perhaps not surprising that empirical evidence is mixed and quantitative meta-analytic summaries suggest rather weak relationships. A meta-analysis by Bücker et al. (2018) reports an average correlation of .16 and another one by Kaya and Erdem (2021) results in an average relationship (Fisher's z) of .17. Looking at these numbers alone, one might be tempted to conclude that academic achievement and socio-emotional well-being are relatively independent from each other and therefore could also be addressed by independent measures. In the following, however, I would like to highlight that such an average relation of *between-person differences* may not be informative about the mechanisms that link academic achievement and well-being at the level of individual students, that these mechanisms may in fact be quite heterogeneous across students, and that there is therefore much to be gained by also considering relationships at the level of *within-person variability* by taking a dynamic perspective on the interplay between academic achievement and well-being.

3. The relationship between academic achievement and well-being: Within-person relationships

A central insight that has received increasing attention in psychology in recent decades is that relations observed at the level of between-person differences may not be informative about relations at the level of the individuals underlying these between-person differences. Only under strict conditions (i.e., ergodicity; Molenaar, 2004), inferences from between-person relations to within-person relations are possible. Individuals may differ from each other in their within-person relations and the average within-person relation may differ from the between-person relation. Figure 1 provides an illustrative example. It shows results from the FLUX study (Dirk & Schmiedek, 2016), in which 110 third and fourth graders participated in smartphone-based ambulatory assessments several times a day for up to 31 days. On these occasions, they completed different working memory tasks and several self-report measures, including ratings of task-related enjoyment. The main scatterplot shows the positive relationship between working memory performance and enjoyment averaged over all measurement occasions for each child and indicates a positive relationship (r = .33) – children who perform better on average tend to enjoy working on the tasks more. However, when looking at the level of within-person variation across the different measurement occasions for individual students, the picture can be quite different. In the example, two students (Child 1 and Child 2) with very similar average levels of performance and enjoyment show radically different within-person relationships – for Child 1 this relationship is quite strong (r = .56), for Child 2 there is no systematic relationship at all (r = -.01). Neither one is well characterized by the between-person correlation of .33. Murayama et al. (2017) provide further illustrative examples of heterogeneous within-person relationships in educational psychology research contexts.

Such heterogeneity of within-person relationships suggests that the causal mechanisms producing the observed relationships may also differ across individuals. And even when similar within-person relationships are observed, the underlying causal mechanisms may still be different. Considering the relationship between academic achievement and socio-emotional well-being, there may be achievement-oriented students for whom achievement is a primary source of self-esteem and well-being. For others, their success in learning may be highly dependent on the absence of negative emotions – which would also produce a positive within-person relationship between achievement and well-being, yet based on a different causal mechanism. It may also be the case that an observed positive relationship is produced by third variables that mutually influence both

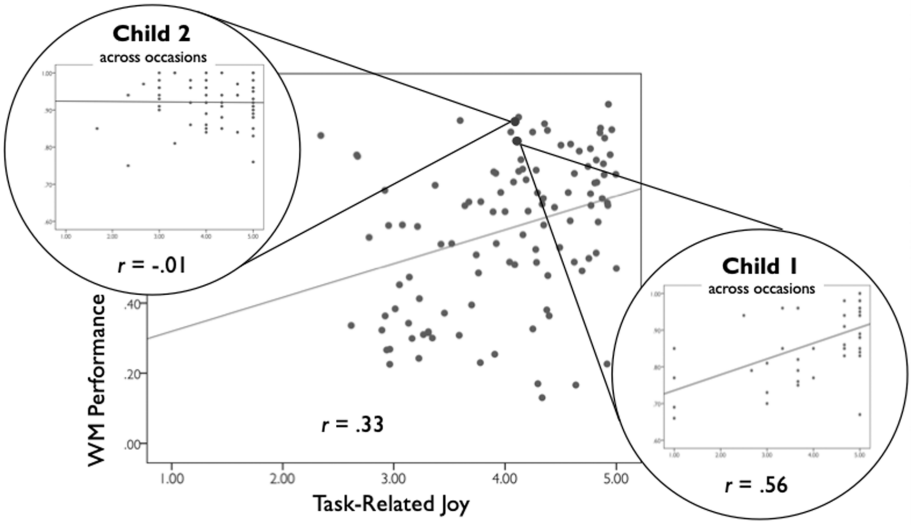

Figure 1. Comparison of the between-person relationship of working memory performance and task-related enjoyment in $N = 110$ children participating in up to 31 days of ambulatory assessment in the FLUX study (Dirk & Schmiedek, 2016) with the within-person relationships of two selected children across study occasions. Working memory (WM) performance is a composite of accuracy on numerical and figural-spatial WM updating tasks with different memory load conditions (see Dirk & Schmiedek, 2016). Task-related joy is a composite of self-rating on the items "*I just had a lot of fun working on the (tasks and) questions overall.*", "*I just enjoyed working on the (tasks and) questions.*", and "*I just found working on the (tasks and) questions boring.*" (reversed item) with 5-point Likert scales.

achievement and well-being, such as day-to-day variations in sleep quality or health status. It is even possible that the relationship may be negative for individual students. Consider a child who performs best at times when parental pressure to perform well is high, which for this child is associated with lower levels of well-being due to stress and test anxiety. Or consider an adolescent who goes through periods of spending a lot of time with peers, which has a positive impact on socio-emotional well-being by meeting the need for social inclusion, but a negative impact on time spent learning. While these examples are speculative, they should serve to illustrate that a weak between-person correlation between achievement and well-being may mask a large heterogeneity of individual relations and underlying causal mechanisms. If known, these different mechanisms would also suggest different individual starting points for interventions aimed at improving achievement and well-being. However, it is only by examining within-person variation with measurement-intensive longitudinal studies that we may be able to identify such between-person variability in relationships and mechanisms.

With the growth of measurement-intensive studies, empirical evidence of such between-person variability is beginning to accumulate in several research areas of psychology, including educational psychology. For example, Niepel et al. (2022) investigated the cross-lagged relationships between mathematical self-concept and perceived mathematics achievement in 372 secondary school students, using self-report measures after each mathematics lesson over a three-week period. They found significant average cross-lagged effects in both directions (i.e., better performance in one lesson predicted better self-concept in the next lesson and vice versa). There were also significant random effects, indicating between-person differences in the strength of these within-person effects. Interestingly, the correlation of these random effects was negative (r = -.56), indicating that the reciprocal effects tended to be stronger in one direction or the other for different groups of students.

Such an indication of potential heterogeneity in within-person relations of constructs related to performance and well-being was also reported by Neubauer et al. (2019). Using data from the FLUX study (see above) and mixture modeling, they were able to identify latent classes with different patterns of relations between working memory performance and four dimensions of momentary affective well-being (positive and negative affect, activation and deactivation). While two of the latent classes showed relatively strong (or weak) within-person relations of performance with all affect dimensions, the other two latent classes were characterized by performance being specifically associated with negative affect and deactivation or exclusively with activation. Again, such heterogeneity may suggest different promising approaches when considering individualized interventions (e.g., reducing negative affect or increasing levels of activation).

4. From bivariate within-person relations to complex dynamic networks

In clinical psychology, research on mental disorders has in recent years increasingly adopted measurement-intensive studies and focused on within-person processes, typically assessed in patients' everyday life contexts using ambulatory assessment (Trull & Ebner-Priemer, 2013). This growth has fostered a parallel new conceptual development based on dynamic systems theory and network modeling approaches (Borsboom, 2017). The general motivation behind this is to move away from the traditional view in psychiatry and clinical psychology, which conceptualizes mental disorders as separate categories that

are characterized by a latent state (e.g., "depression") that manifests in a set of typical symptoms (e.g., lowered self-esteem, loss of interest, suicidal ideation). On the basis of these symptoms, the clinician attempts to make a categorical diagnostic decision about whether a, and if so which, disorder is present, and therapeutic interventions are then based on that diagnosis. The new view abandons the idea that there is a latent disorder state that causes a specific set of symptoms to emerge or increase and instead views individuals as complex systems (Fried, 2022). These can be modeled as multivariate networks of psychological (e.g., mood), physiological (e.g., sleep), and psychopathological symptom (e.g., catastrophic thinking) variables that can influence and interact with each other in complex, dynamic, and potentially highly idiosyncratic ways. Mental disorders arise when such networks, for example through self-reinforcing cycles (e.g., depressed mood → reduced social and physical activity → depressed mood), are driven into unhealthy states from which it is difficult to escape (see next section). The goal of applying these conceptual ideas in research and clinical application is to estimate and understand the networks of individual patients, to use them to reflect on the causal processes that induce and stabilize disordered states, and to identify promising variables to intervene on and break up the malignant dynamics. While applications of dynamic networks typically are rather exploratory in nature (apart from that the selection of variables ought to be driven by theoretical considerations) and take an idiographic perspective, there are also developments towards confirmatory approaches (Du et al., 2025) and towards integrating idiographic and nomothetic perspectives by attempting to group similar individual network structures (e.g., Beltz et al., 2016).

Recently, similar conceptual ideas from dynamic network theory have found their way into educational research. For example, Moeller et al. (2022) have proposed the DYNAMICS framework, which conceptualizes the development of achievement-related motivational and emotional traits as growing out of complex within-person short-term processes of a network of variables that are central to the situated expectancy-value theory (Eccles & Wigfield, 2020). Empirical applications in educational research are still few, with a nice example being a study by Tamura et al. (2022). In this study, daily questionnaires from four participants were analyzed who provided self-reports on a very rich set of 31 components of motivational engagement with regard to their daily work. This set contained motivational reasons, goals, expectancy beliefs, perceived costs, satisfaction of different needs, as well as discrete emotions and global affective experiences, including psychopathological symptom variables (e.g., stress, depression). Based on a total of 595 data points (of four participants combined), a dynamic network of contemporaneous relationships between all variables was

estimated. This resulted in relatively independent clusters of motivational variables on the one hand and emotional and psychopathological symptom variables on the other hand. Although this study was rather exploratory and based on only very few participants, it illustrates how motivational engagement as a central driver of all academic achievement can be examined from a dynamic perspective that takes into account a variety of relevant variables, including those relevant for well-being and mental health. Given the application of dynamic network concepts in both clinical and educational research, consideration could be given to adopting other dynamic systems concepts developed in mental health research and assessing their usefulness for educational research, including concepts of risk and resilience.

5. A dynamic systems perspective on risk and resilience

In the field of mental health research, concepts derived from dynamic systems theory have also been employed to develop novel perspectives on the concepts of risk and resilience. A central concept in this regard is that of attractor landscapes (Heino et al., 2023). These are employed to delineate relatively stable regions within the overall state-space (comprising all potential states) of a system. They have been utilized extensively across diverse scientific disciplines (e.g., ecology) to model the reactions of complex dynamic systems to external influences, their temporal development, and the potential transitions between states that differ markedly from one another (e.g., between rainforest and savanna in tropical regions). When depicted as a two-dimensional topography, these disparate attractors can be conceptualized as valleys. These systems are characterized by the tendency for mild perturbations to produce variability around the equilibrium point, which is located at the bottom of the valley. Only strong perturbations provide the energy necessary to escape the attractor and potentially move into a different one.

The application of these general concepts to mental health research is illustrated in Figure 2, which depicts a simplified case with only one dimension (i.e., negative affect) describing the overall state-space. This space contains two attractor states: one representing affective well-being within the normal healthy range and the other representing depression. Panel A depicts a system that can be described as resilient. Mild perturbations, such as those caused by daily hassles, may elicit emotional reactions that are characterized by some short-term and transient variability. Getting out of the attractor state of such normal well-being and into a depressed state would take a quite strong perturbation, for example, a traumatic life event.

In contrast, Panel B portrays a system at risk. In this scenario, the equilib-

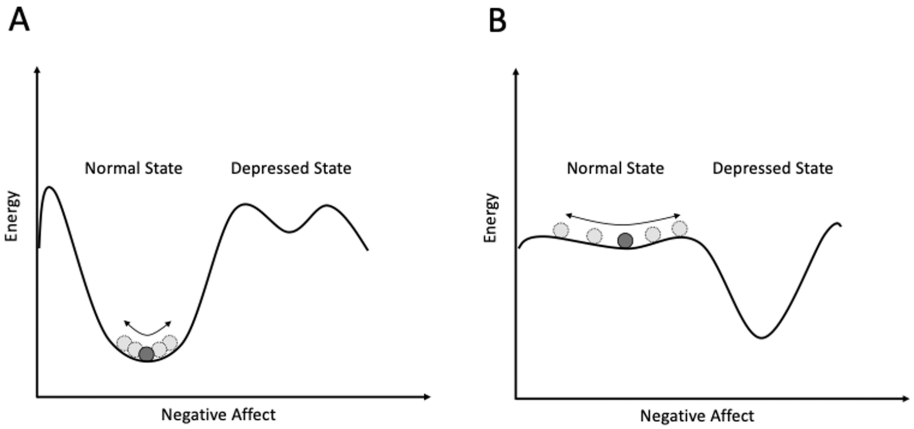

Figure 2. Illustrations of resilient (A) and at-risk (B) states of mental well-being (adapted from Wichers et al., 2015). The solid dark grey points denote systems in local "attractor" or "equilibrium" states. Perturbing the resilient system (A) away from the relatively stable normal state and into the depressed state requires a lot of energy (i.e., a strong perturbation). The at-risk system (B) is in a shallower normal attractor state out of which it can be moved with less energy (i.e., a weaker perturbation).

rium state of normal well-being is less stable and a relatively minor disturbance can result in reaching and passing the tipping point to the attractor state of depression – out of which it is then difficult to escape (e.g., requiring a psychotherapeutic intervention).

These two scenarios can be connected to the concept of dynamic networks introduced above. It can be argued that a resilient state as depicted in Panel A results from a network with rather weak connections between a set of variables (called nodes) relevant for depressive symptomology. Perturbing one node (e.g., experiencing an embarrassing social interaction) may affect other nodes (e.g., lowering self-esteem and motivation for further social interactions) to some degree, but only some and only temporarily. The at-risk state of the system depicted in Panel B may result from the presence of strong temporal connections between the network nodes (Wichers et al., 2015). With such, single perturbations may result in cascading effects and vicious cycles among different symptoms (e.g., sleep and concentration problems) that have reciprocal, unfavorable effects on each other. From a statistical perspective, it has been postulated that networks being in such an at-risk state and moving towards tipping points that may lead to disordered states may exhibit early warning signs, such as increased variance or high autocorrelation (termed "Critical slowing down", van de Leemput et al., 2014). Although the prediction of the onset of episodes of mental disorder based on such warning signs presents methodological challenges and the empirical findings to date are inconclusive (see Helmich et al.,

2024, for a critical review), the conceptual ideas warrant further development and investigation – and should be evaluated for their potential beyond the research domain of mental disorders.

Among the research topics investigated in the field of educational research, one may identify ones in which the existence of substantially different attractor states and the question of how learners change from one into the other are of central interest. This appears to be relatively straightforward for certain expressions of neurodiversity, such as autism and attention-deficit/hyperactivity disorder. These are associated with typical symptoms that can be characterized as attractor states ("meltdown" or "lockdown" states in autism, distracted states in ADHD). Also, in the more general range of learners' behavior there are states seen as beneficial (e.g., the experience of flow) or maladaptive (e.g., procrastination). It is of importance to gain a deeper understanding of how learners become stuck in these states and how they transition in and out of them. Regarding social interactions in the school context, being mobbed may be an example of a state that individual students may get trapped in, due to vicious self-reinforcing cycles of reciprocal interactions. These examples illustrate situations for which it can be argued that complex, dynamic, and idiosyncratic within-person processes must be taken into account. However, there is still little empirical research that attempts to adequately capture these complex phenomena at the within-person level. The aforementioned concepts and their associated methodological innovations may provide promising new avenues for advancing this research.

6. Summary

The individual dynamics of processes related to academic achievement and to socio-emotional well-being may be highly heterogeneous across individuals. For example, individuals may differ in which antecedents for both domains are relevant, in whether these antecedents do overlap, and how they are related to each other. Thus, questions about whether the two domains show trade-offs or reciprocal effects that can lead to virtuous or vicious cycles may have individuum-specific answers. To better understand this heterogeneity, the corresponding multivariate within-person processes need to be studied with intensive longitudinal data. Ideally, such investigation would take place on the individual level. However, if the collection of long time series data necessary for such individuum-specific analyses is out of reach, multilevel approaches with samples of individuals participating in intensive longitudinal data collections with a feasible number of occasions do also allow to capture between-person differences in within-person processes and thus to get closer to the heterogene-

ity of individuals. Concepts from dynamic systems theory can help to understand and model (transitions between) different states and offer new perspectives on risk and resilience – in mental health as well as in learning processes. Ultimately, understanding individual network dynamics could help to identify relevant time points or periods for intervention and the relevant variables to intervene on – thus opening up promising avenues for personalizing interventions.

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