ADVERSITY AND RELATIVE PERFORMANCE

**How does adversity shape performance across different abilities in the same person?**

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**Abstract**

The idea that some abilities might be enhanced by adversity is gaining traction. For example, research leveraging the hidden talents approach has uncovered a few narrow, context-dependent abilities enhanced by exposure to adversity. Yet, in order for a field to grow, we must not dig too deep, too fast. In this paper, we compliment adaptation-based research with principled exploration. To do so, we draw on the basic insights of adaptation-based research: enhanced performance manifests within individuals and reduced and enhanced performance can cooccur. Although commonly assumed, this assertion is rarely tested. Thus, to detect enhancement, a variety of ability measures are needed examine *relative* performance differences. However, rather than using adaptive-logic to predict *which* abilities are enhanced or reduced, we develop statistical criteria to help interpret three different data patterns: reduced, enhanced, and intact performance. We use these criteria to analyze data from the Study of Early Childcare and Youth Development (SECCYD) to examine how adversity shape within-person performance across ten abilities in the Woodcock Johnson Cognitive and Achievement test battery. Our goal is to document adversity-shaped cognitive profiles, identify possible drivers of reduced overall performance, map out sets of ‘intact’ abilities, and discover new enhanced abilities. We argue that principled exploration with clear criteria can help break new ground, re-map old territory, and fuel theory development.

**How does adversity shape performance across different abilities in the same person?**

Developmental science commonly asserts that adversity-exposure during development reduces cognitive performance, an assumption built on decades of empirical findings (Duncan et al., 2017; Farah et al., 2006; Hackman et al., 2010, 2014; McLaughlin et al., 2019; Raby et al., 2015). In recent years, however, adaptation-based frameworks, rooted in the idea that adversity might enhance certain abilities, have complimented this work—and it is gaining traction (Ellis et al., 2017, 2020; Frankenhuis, Young, et al., 2020; Frankenhuis & de Weerth, 2013; Frankenhuis & Nettle, 2020). Since its inception, the goal of adaptation-based frameworks has been to inspire a more well-rounded view of adversity and its influence on abilities—one that incorporates both the struggles and strengths of people from disadvantaged backgrounds (Frankenhuis & de Weerth, 2013). As it develops, the core task of adaptation-based research is to “uncover a high-resolution map of specific cognitive abilities that are enhanced as a result of growing up under high-adversity conditions” (Ellis et al., 2017, p. 562).

To illustrate this map, research has used confirmatory study designs, which has gleaned useful insights. Yet, to cultivate growth in an emerging research program—where there is little known and much to learn—we must not dig too deep, too fast. Without complimentary approaches, exclusive use of confirmatory designs can create tunnel vision and miss new insights. In this paper, we use a complimentary approach to confirmatory research: principled exploration. Our broad goal is to contribute to drawing our map of adversity-shaped abilities. Our specific goal is to document adversity-shaped cognitive profiles in standard cognitive assessment. This allows us to identify possible drivers of reduced overall performance and map out sets of ‘intact’ abilities. To do so, we draw on the essential features of adaptation-based frameworks and use them to drive our exploration into new territory and to re-map familiar ground.

**Essential Features and Empirical Insights from Adaptation-based Frameworks**

Adaptation-based research has several essential features. First, it assumes development shapes the individual, and their abilities, to fit the local environment (Frankenhuis, Young, et al., 2020). Second, because environments differ in the challenges they pose (resource-scarcity versus violence exposure), development shapes abilities according to specific challenges. Thus, one’s abilities are thought to match the challenges of one’s lived experience. These features are useful guideposts for confirmatory hypothesis generation. Using them as building blocks, it is easy to construct an intuitive bridge between an ability and an environmental challenge. For example, a researcher might identify a specific challenge posed by a dimension of adversity (e.g., threats to safety in high crime neighborhoods) and an ability needed to meet the challenge (e.g., heightened vigilance).

This approach is appealing because it forces researchers to be specific and logically tie together environments and abilities. It has also been successful in discovering a handful of interesting adversity-enhanced abilities, especially in harsh and unpredictable environments. For example, past work has proposed that constantly changing environments (i.e., unpredictable environments) might shape the ability to track and respond to changing information. Using this logic, research built an intuitive bridge between unpredictable environments and two abilities –attention-shifting and working memory updating. The idea is that these two abilities help people deal with changes in the environment. They found that exposure to more unpredictable environments tend to enhance both (Fields et al., 2021; Mittal et al., 2015; Young et al., 2018).

Adaptation-based research has also focused on testing content, or the notion that performance should improve when the testing content matches the lived experience of people exposed to adversity. For example, Frankenhuis and colleagues (2020) hypothesized that exposure to violence might enhance reasoning about social dominance hierarchies—but not for neutral content, such as age. Their study revealed that youth exposed to more violence were equally or more accurate when asked to memorize social dominance relationships than youth exposed to less violence. Using a similar experimental paradigm, Young and colleagues (2022) examined how real world compared to abstract testing stimuli affects performance on attention shifting and working memory tests. They found that adversity-exposed youth score higher on working memory updating tasks with real world compared to abstract content.

These findings are new and exciting, but they come with caveats. First, studies are difficult to compare because they use different measures and designs. Second, findings are mixed. For example, some adaptation-based studies find that conditions thought to raise performance actually lower it. For example, youth from poverty tended to score lower on math items about social relations, money, and food—items thought to be particularly relevant to adversity-exposed youth—compared to other math items (Duquennois, 2022; Muskens, 2019).

Overall, the essential features of adaptation-based have led to interesting confirmatory studies and findings. It has also generated at least two general insights. First, although it is possible for adversity to enhance performance between individuals (e.g., low versus high adversity exposure), empirical findings suggest effects mostly occur within individuals (Fields et al., 2021; Frankenhuis, de Vries, et al., 2020; Young et al., 2022). Second, enhanced performance appears to be highly context specific, e.g., depend on testing content, context, and ability type (Fields et al., 2021; Frankenhuis, de Vries, et al., 2020; Mittal et al., 2015; Nweze et al., 2021; Young et al., 2018, 2022). adaptation-based studies have studied abilities in an isolated and piecemeal fashion, in part, because confirmatory designs tend to narrow a study’s scope. This means we know little about enhanced abilities compared with the broad landscape of ability measures.

**Motivating Principled Exploration**

Adaptation-based, confirmatory approaches are clearly useful, but they also have pitfalls. Emerging research programs have yet to lay basic groundwork for testing theories, such as auxiliary assumptions or boundary conditions (Scheel et al., 2021). This reduces our ability to understand conflicting findings. For example, studies of ecologically relevant content are mixed (Duquennois, 2022; Muskens, 2019). Is this because each study tested different types content, measured different abilities, or both? In addition, the logic behind confirmatory studies can easily flipped. For example, exposure to unpredictable environments is thought to reduce inhibition, or the ability to resist distractions. If threats and opportunities arise, it is important to quickly respond, rather than ignore them to focus on a long-term goal. But adaptive logic can assert the exact opposite. For example, inhibition is enhanced by unpredictable environments because it helps to focus on what is important there are constant distractions.

Our aim, is to complement adaptation-based, confirmatory research with principled exploration (Flournoy et al., 2020; Rozin, 2001). We see two benefits for doing so. The first is to re-examine established patterns with a new lens. For example, both deficit and adaptation-based perspectives assume that adversity should reduce performance on standard assessments of cognitive ability (Ellis et al., 2020; Frankenhuis, Young, et al., 2020; Hackman et al., 2010; McLaughlin et al., 2019; Ursache & Noble, 2016). Yet, these tests are comprised of many different subtests, and may show unique patterns that diverge from widely used composite scores. The second is to feed theory with useful description. One reason why certain abilities have not been examined is because it is difficult to imagine an intuitive bridge between some abilities and adversity exposure. However, this does not imply the presence or absence of a functional link. Instead, links between abilities and environments can be explored, described, and follow-up with new theory development. Therefore, we return to the map of cognitive abilities that might be shaped by adversity and ask “what territory needs exploration and which areas may need re-mapping?”

Rather than relying on confirmatory hypotheses to guide our design, we draw on the basic insights of adaptation-based research. There are two related features of adaptation-based work that guide the current work. First, enhanced performance tends to manifest within individuals. Second, adversity can shape performance by enhancing and reducing performance at the same time. For example, it can reduce general cognitive resources while also enhancing abilities that are essential in adverse environments. Although commonly assumed, this assertion is rarely tested. This implies that, to detect enhancement, a variety of ability measures are needed examine *relative* performance differences. Therefore, we use 1) a within person designs and 2) test a wide variety of abilities.

To carefully examine and interpret data in principled exploration, it is helpful to develop inferential and statistical criteria. For example, rather using adaptive-logic to predict *which* abilities are enhanced or reduced, we can ask what criteria are needed for evaluating and interpreting different data patterns? In addition, research typically focuses on comparing reduced versus enhanced test performance, but some abilities might remain ‘intact’ (unaffected) by exposure to adversity (Frankenhuis, Young, et al., 2020). We know little about the intact abilities of people exposed to adversity. We also know little about the drivers of reduced performance on broad and generic measures of ability. For example, deficit approaches have collapsed many abilities into composites and find that adversity exposure reduces performance. However, one possibility is that a smaller set of specific abilities are driving effects. In total, there is still much to learn about the map of adversity shape cognitive abilities, and we argue principled exploration can complement confirmatory research in drawing this map.

**Current Study: Inferential and Statistical Criteria**

Here, we conduct a principled exploration of the cognitive abilities shaped by adversity. To do so, we analyze data from the Study of Early Childcare and Youth Development ([SECCYD](https://www.icpsr.umich.edu/web/ICPSR/series/00233)) to examine how adversity shape within-person performance on ten abilities in the Woodcock Johnson Cognitive and Achievement test battery (Woodcock, 1990; Woodcock et al., 1990). We selected adversity measures that tap two constructs: environmental harshness and unpredictability. We focus on these constructs because they feature many in adaptation-based research on cognitive abilities, both conceptual and empirical (Ellis et al., 2017, 2020; Fields et al., 2021; Frankenhuis, Young, et al., 2020; Mittal et al., 2015; Young et al., 2018, 2022).

In the literature, and in these data specifically, there have been different approaches to measuring them (Belsky et al., 2012; Hartman et al., 2018; Li et al., 2018). For example, for unpredictability, whereas Belsky and colleagues (2012) measured paternal transitions, residential changes, and parental job changes, Li and colleagues (2018) calculated residual variances in income-to-needs ratios over time. There are also other, unexplored ways to capture harshness and unpredictability. In addition to previously used measures, we leverage data from the 1990 Census about the broader ecological context, which has been used to measure the neighborhood context in the SECCYD previously (Bleil, Appelhans, et al., 2021; Bleil, Spieker, et al., 2021). We aggregate Census block-level household income, poverty levels, unemployment, rental housing, and income inequality statistics. Here, we retain more narrow labels for each adversity measure. Specifically, with respect to harshness related variables, we measure income-to-needs and neighborhood disadvantage, a composite of the above Census-based neighborhood variables. With respect to unpredictability, we measure family transitions (paternal transitions, residential changes, and parental job changes), income-to-needs variability (standard deviation in income-to-needs over time), and neighborhood disadvantage variability (standard deviation in neighborhood disadvantage over time).

We use a within-person modeling strategy to examine how exposure to each measure of adversity are associated with *relative* performance differences across many abilities (see Figure 1). This design allows us to compare specific abilities (e.g., short-term memory performance) against overall performance (within-person average performance on all tests) to get a clear picture of how enhanced and reduced performance manifest in parallel.

We outline two sets of criteria for evaluating results, one conceptual and the other statistical. First, our expectations change according to the conceptual framework. For example, under a traditional deficit expectation, we should expect negative overall effects of adversity. Performance on subtests should closely match the overall effect. Under an adaptation-based expectation, we expect an overall negative effect but performance for some subtests is either less reduced, intact, or even enhanced. Our statistical criteria help to quantify the nature of effects. Significant negative and positive effects of adversity suggest reduced and enhanced overall performance, respectively. A null effect will be followed up with an equivalence test to determine if the effect falls within a range too small to be practically meaningful (Lakens et al., 2018). When an effect falls within this range, overall performance is ‘intact’ or unaffected by adversity.

For the current study, we expect overall effects to be negative. This is because overall scores closely map on to Woodcock Johnson achievement composites used in prior work in the SECCYD and show negative effects with income-to-needs and maternal education (e.g., Fraley et al., 2013). For subtest performance, our modeling strategy allows us to quantify performance as a function of adversity in two ways. First, we can test whether the effect adversity on each subtest is different from zero. A positive and negative effect suggests enhanced and reduced performance, respectively. Second, we compare subset performance against overall performance. This means we can determine whether subtest performance is significantly more negative, less negative, or even positive compared to overall performance. For both types of effects, we can determine if they are practically equivalent to either zero or to the effect of adversity on overall performance. Subtest performance is intact when the effect of adversity effect on a subtest is practically equivalent to zero.

In sum, we believe that adaptation-based frameworks can provide useful guideposts, but one should use shovels, not scalpels, when breaking new ground. Principled exploration can complement confirmatory research by helping break new ground, re-map old territory, and fuel theory development. In doing so, we position ourselves to identify the key drivers of reduced overall cognitive performance, map out sets of ‘intact’ cognitive abilities, and discover cognitive enhancements.

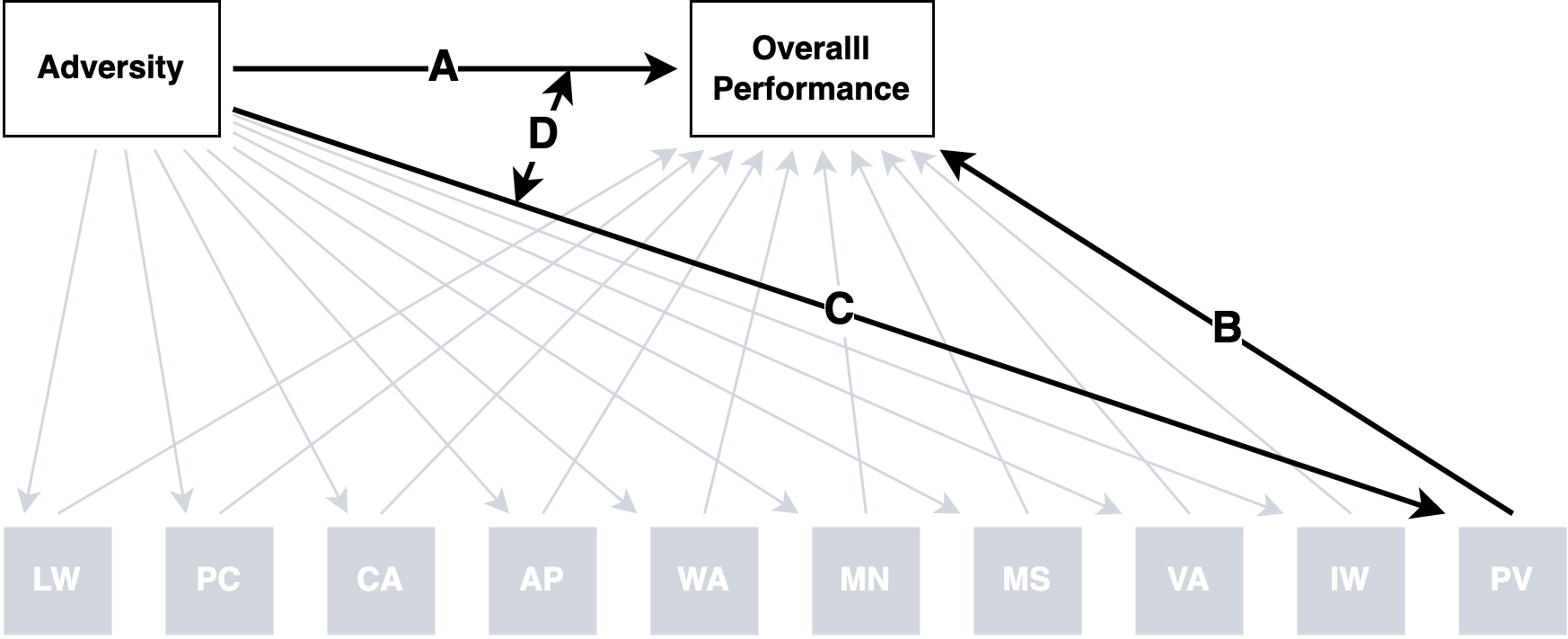


Figure 1: We are interested in the effect of each adversity measure on a person’s overall score, measured as a formative average of each subtest. (A) is the main effect of adversity on overall performance. (B) is the main effect of a subtest. (C) is the simple effect (slope) of adversity for a particular subtest. (D) is the interaction effect that measures the difference between A and C. A significant simple slope means the C ≠ 0 and a significant interaction means A ≠ C. So, when C is significant, it means that adversity affects performance. When D is significant, it means that adversity affects a subtest in a different way than A (overall pattern).

**Method**

**Participants**

Families were initially recruited for the NICHD SECCYD in 1991. A total of 1364 families met all the prescreening criteria, namely that mothers: (a) were age 18 or older, (b) did not plan to move, (c) had a newborn without any known disabilities (and could leave the hospital within one week), (d) had no history of substance abuse, (e) could speak English, and (f) lived within 1 hour driving distance from the research lab and were in a relatively safe neighborhood. More information about recruitment and selection procedures is available from the study (NICHD Early Child Care Research Network, 2005; see https://www.icpsr.umich.edu/web/ICPSR/series/00233). The current analyses included participants with non-missing data on most predictors and outcome variables through age 15 (N = 1156).

**Measures**

***Predictors***

**Unpredictability.**

**Harshness.**

***Outcomes***

**Picture vocabulary.**

* verbal comprehension/crystallized knowledge
* 5 assessments, 54 months, grades 1, 3, 5, and at 15 years

**Verbal analogies.**

* verbal fluid reasoning and crystallized knowledge
* 2 assessments, grade 3 and at 15 years

**Passage comprehension.**

* vocab and comprehension skill
* 3 assessments, grades 3, 5, and at 15 years

**Applied problems.**

* practical math problem solving skill
* 5 assessments, 54 months, grades 1, 3, 5, and at 15 years

**Memory for Sentences.**

* short term retrieval
* 3 assessments, 54 months and grades 1 and 3

**Incomplete words.**

* auditory processing
* 2 assessments, 54 months and grade 1

**Memory for names.**

* long term retrieval
* 2 assessments, grades 1 and 3

**Letter-word identification.**

* verbal knowledge
* 4 assessments, 54 months, grades 1, 3, 5

**Word attack.**

* auditory processing
* 2 assessments, grades 1 and 3

**Calculations.**

* math calculations
* 2 assessments, grades 3 and 5

**Results**

**Data Analysis Strategy**

**Primary Analyses**

**Secondary Analyses**

**Discussion**

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