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Continuity and Stability in Development

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Abstract

Developmental science is centrally concerned with both consistency and change in characteristics through time. Consistency and change in development are tracked by group mean level continuity and individual order stability. Group mean level and individual order consistency and change are both developmentally informative and can co-exist conceptually and empirically as the two are partially orthogonal perspectives on development. Continuity and stability are broadly applicable to characteristics of the individual, dyad, and environment. Significantly, absent the distinctions we draw between mean level continuity and individual order stability, researchers who use the terms willy-nilly leave their readers in the dark as to which key feature of development is meant. In this article, we distinguish the two types of consistency and change, their measurement, importance, moderation, and implications.

Consistency and Change in Development

Developmental science is centrally concerned with both consistency and change in characteristics (constructs, structures, functions, or processes) through time. Consistency and change in development are normally tracked in two ways: group mean-level consistency or change and individual-order consistency or change. Here we disambiguate the two by employing the distinctive polarities “continuity/discontinuity” and “stability/instability,” respectively. Group mean-level continuity/discontinuity and individual-order stability/instability in development are both theoretically and methodologically informative, and can co-exist conceptually and empirically as the two are partially orthogonal perspectives on development. For example, children change dramatically in mean level of their language skill (discontinuous) as they develop yet remain rather consistent in rank-order relative to one another (stable) over time. Although *development* is often identified with change and transformation, not all characteristics alter in development, and development equally includes consistency.

In this article, we distinguish the two types of consistency and change, their measurement, importance, moderation, and implications. Curiously, not every repeated-measures longitudinal developmental study systematically reports both continuity and stability in the data, but could, and analyses of both should be *de rigueur*. These twin foundational

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complementary concepts are of long-standing interest in developmental science, and both have therefore been considered in the past by many scholars (e.g., 1-5) – there is little new under the sun (Ecclesiastes 1:9) – so our formalization and explication here is only a next logical (but nonetheless important) contemporary treatment. Here we are discussing continuity/discontinuity and stability/instability in quantitative terms. Some developmentalists refer to qualitative changes in ontogeny (e.g., moving from gestures to spoken communication) as "discontinuous" as well. It is dismaying that, at this stage of its maturity, our field still does not command adequate vocabulary to distinguish these basic constructs. Hence, we choose these two terms – continuity and stability – to refer to the degree of consistency in group means and individual differences, respectively, over development. To facilitate reader digestion, we draw examples from a single developmental domain – language – but continuity and stability of course apply to all developmental domains and are broadly applicable to characteristics of the individual, dyad, and environment.

Continuity and Stability

Continuity

Think of continuity as consistency, and discontinuity as change, in the group mean level of a characteristic through time. A continuous characteristic is one that a group displays at the same mean level over time (Figure 1A); a discontinuous one that the group either increases or decreases in mean level over time (Figure 1B and C). Between two time points spaced close together, child vocabulary may not change, but between two others that may be equally closely spaced (as around the so-called "vocabulary spurt") or certainly over the longer term children change in the mean amounts of their vocabulary (6).

Stability

By contrast, think of stability as consistency, and instability as change, in the relative order, standing, or rank of individuals in a group on a characteristic through time. A stable characteristic is one that some individuals display at high levels relative to others in a group at one point in time and again display at relatively high levels at a later point in time, where other individuals display lower levels at both times (Figure 2A). Individuals show instability in a characteristic if they do not maintain their relative order in the group through time (Figure 2B). Over time, children tend to maintain their relative order in their language abilities (6, 7).

Continuity and stability combine to paint a more complete, if nuanced, portrait of development. Discontinuity-and-stability describes a characteristic whose group mean level changes over time but individuals in the group remain consistent in their relative order over time (Figure 3C; vocabulary). Alternatively, the group mean level could remain the same over time, but individuals change in their order over time: continuity-and-instability (Figure 3B), and so forth for continuity-and-stability (Figure 3A) and discontinuity-and-instability (Figure 3D). *These patterns are development.*

Measurement

Continuity and discontinuity are conventionally indexed by mean difference tests across time (the Student's paired *t*-test or *F*-test in repeated-measures analysis of variance for multivariate continuously and normally distributed data, or the Wilcoxon signed-rank test for ordinal or non-normally distributed data). Effect size is a practical guide to the meaning of discontinuity: Cohen's *d* (8) is the difference between two means divided by the pooled standard deviation for the data. An accepted rule of thumb is that $d = .20$ is a small, $d = .50$ a medium, and $d = .80$ a large effect. For multivariate *F*-tests, partial eta-squared (η^2_p) provides an effect size, with .01 indicating small, .06 medium, and .14 large effects (8).

Stability and instability are conventionally indexed by correlation (Pearson's *r* or Spearman's ρ or β for multivariate continuously and normally distributed data in regression analysis). In describing effect sizes of correlations and standardized βs, Cohen's (8) terminology is $r \approx .10$ for small, $r \approx .30$ medium, or $r \approx .50$ large effect sizes. Significantly, a large time-1 to time-2 correlation of, say, $r = .50$ in a measure leaves a great deal of time 1 – time 2 variation unexplained, $1\text{-}r^2 = 75\%$. Thus, characteristics may substantially persist, but stability over time is far from perfect and even "stable" characteristics only explain portions of common variance.

Effect size is critical to understanding continuity and stability. However, it is erroneous to dismiss small effects as unimportant or uninfluential. In developmental science, even small differences early in the life course can cumulate over time and so fashion meaningful variation in ontogenetic trajectories (9).

Continuity and stability are easy to confuse with latent change (growth curve) models. Like continuity and stability, latent change models measure change (or non-change) over development, but they focus on different aspects of development. Whereas continuity and stability measure change at 2 levels of analysis (group mean and individual order), latent change models measure within-person change and trajectories, or the shape of the developmental function in terms of the intercept and slope (Figure 4). The intercept represents the group mean level at Time 1. The slope represents the average rate of change from the intercept over time. Hence, latent change models provide information about the initial average position and the shape (linear or nonlinear) and direction (increasing or decreasing) of change over time as well as whether the initial position informs later change (the correlation between the intercept and slope). Latent change models do not provide information about individual-order stability over time, nor do they directly measure change in mean level over time (but continuity can be inferred from the intercept and linear slope). Growth curve models generally require at least 3 waves of longitudinal (within-subject) data measured in the same metric; continuity and stability require only 2 waves of longitudinal (within-subject) data. Continuity analyses require measurement in the same metric at each time point, but stability analyses do not. Hence, continuity and stability and latent change models are complementary analyses with different goals and data demands.

Modelling Stability

Developmental science regularly employs three main models to assess stability. One model describes homotypic stability, the maintenance of individual order in the same characteristic measured in the same metric through time (A→A). In language, vocabulary size exemplifies a characteristic that might be indexed the same way at different ages and shows stability. The Communication Domain of the Vineland Adaptive Behavior Scales is homotypically stable in children between 3 years and 4 years, 11 months (r = .86) and in children between 5 years and 6 years, 11 months (r = .89; 10) as is mean length of utterance (MLU) between 18 and 57 months (11) and between 31 and 46 months (12). Homotypic stability (between the same measures) may represent a liberal (upper bound) estimate of stability because of shared source and method variance, practice effects, and the like.

A second model describes heterotypic stability, the maintenance of individual order on different manifest characteristics through time where the different characteristics are theoretically related and presumed to share the same underlying construct (A→A'). Models of heterotypic stability typically postulate that some shared characteristic ($\bar{A}$) in the individual underlies stability between characteristic A and characteristic A'. Oral production at 3 years predicts language comprehension at 5 years (13), and letter naming at 4 years predicts emergent writing and familiarity with the alphabetic system at 5 years (14). Heterotypic stability (between different measures) may represent a conservative (lower bound) estimate of stability because of the variance introduced by differences in assessment measurements and procedures used at different times.

One way that heterotypic stability is modeled is with latent variables. Studying stability poses unique challenges for any characteristic that is componential and changes dramatically with development, like language. For example, successful communication at 20 months might be indicated by comprehension, vocabulary, and the ability to combine words, whereas successful communication at 48 months might be indicated by relating complex and novel ideas verbally, understanding how words relate to one another, and communicating in contextually and culturally appropriate ways. A primary methodological issue is to identify sensitive and reliable measures of language derivable from varying assessment tools and different observed variables that track child age appropriately (15). Latent variables provide a solution to this common challenge because they take more aspects of the characteristic (language) into account by accommodating the perspectives of multiple domains, methods, and reporters, and they give more precise statistical estimates by relegating variance uniquely associated with rater bias, random measurement error, or measurement-specific variance to a residual term. Thus, using latent variables permits measurements of a characteristic (language) to vary across time (as the construct does) but keeps comparability, which is prerequisite to (heterotypic) stability assessment.

Stability is usually ascribed to consistency of that characteristic *in* the individual. However, stability might also be attributable to other stable endogenous (genetic, biological, maturational) characteristics in the individual that are related to the target characteristic (16, 17), or stability might be attributable to a stable environment (maternal language addressed to the child) that supports stability in the target characteristic (18). Complementing the first two models of stability – homotypic and heterotypic – is a third model of *mediated stability*

that describes stability in a characteristic A, or stability between characteristic A and characteristic A', as explained by a mediating characteristic X that is remote from characteristics A and A'. For example, characteristic A at Time 1 relates to characteristic A or A' at Time 2 not because $\bar{A}$ is stable but because some characteristic X carries the effect of A at Time 1 on A or A' at Time 2. Mediated stability predicts that, once the contribution of the third variable (X) is removed, stability will change, attenuating if X is the mechanism that produces stability (19). Both word types and MLU in children's spontaneous speech are stable from 13 to 20 months, even taking into consideration maternal word types and verbal responsiveness, respectively (20). However, maternal responsiveness partially mediates the heterotypic stability between prelinguistic gestures and later language in developmentally disabled children (21). Including potential mechanisms of action or confounding third variables as mediators is an important step toward identifying the locus of stability and understanding conditions that maintain stability across time.

The Importance of Developmental Consistency and Change

Developmental science is concerned with description, explanation, prediction, and optimization. Consistency and change are foci of study because they are developmentally informative about all four goals. Repeated assessments allow researchers to trace developmental trajectories over parts or even the whole of the life span. Descriptions of developmental continuity and stability provide information about trajectories in terms of progress, the duration and consistency in levels or states, individual differences in the time spent reaching new levels or states, and re-occurrences of specific levels or states over time.

Groups and individuals with different, albeit consistent, characteristics, as those with changing characteristics, experience, interpret, and affect environments and events in their lives differently, and so consistency and change affect the course of future development. From the perspective of so-called evocative interactions (22), consistent versus changing characteristics in groups or individuals at one time can be expected to differentially shape responses from the social and physical environments that contribute to later outcomes in those groups or individuals. Vocal and nonvocal infants, and chatty versus taciturn toddlers, have very different childhoods insofar as their interlocutors adjust to match toddlers' stable speech characteristics (23, 24).

Consistency and change are also cornerstones and key conceptions of theory in developmental science. Theorists debate, for example, whether a given characteristic is a trait (and so stable) or a state (and so transient). Many theories of childrearing and family functioning cast each as invariant and are appealing because they subserve more parsimonious developmental models. For example, consistency in moment-to-moment exchanges between parent and child (that is, habitual interactions) forges internal working models and constitutes a basic tenet of attachment theory's claim to be a lifespan perspective in terms of neurobiological systems that underpin, and relational behaviors that express, affiliative bonds (25, 26).

Complementarily, change too is a fundamental feature of many developing systems. Temporality is embedded in developmental systems theory and implies that change is

constant (27). Change is fundamental to adaptation in evolutionary theory and to all stage theories of development (28, 29), including Freud's for psychosexual, Erikson's for psychosocial, and Piaget's for cognitive development. Developmental change may be systematic, normative, and age-related across time (as for vocabulary) or normative and history-related (language acquisition after migration), or change may be stochastic and non-normative (as in grammatical errors like overextensions) or life-event related (second language learning in school). Developmental theories track changes along dimensions of life or ontogenetic time (age from birth to death), family time (location within prior and succeeding generations), and historical time (social and cultural systems that exist and change throughout one's life; 3).

Consistency and change have implications for measurement as well. To be psychometrically meaningful, a characteristic should be stable (at least across short time spans). Consistency is also a gateway to prediction because short-term stability (reliability) of a characteristic (A) sets a statistical limit on that characteristic's predictive validity for the same (A) or a different (A') characteristic (30).

In short, consistency and change alike speak to central definitional, theoretical, and methodological aspects of developmental science.

Moderation of Developmental Consistency and Change

Consistency – continuity and stability – are more parsimonious, organized, and orderly than is change – discontinuity and instability – but, curiously, consistency is neither monolithic nor static, but multidimensional and dynamic and many factors moderate degree of consistency. Individual differences play a role. Consistency is likely (normally) distributed in the population, with some individuals more consistent in their language than others (7). The developmental stage or age of a sample is another parameter. A language characteristic may be stable or continuous between two points in the life span, but unstable or discontinuous between two others, or vice versa, as in sleeper effects (31). Older children are more stable in their language than younger children (7), and generally people are thought to become increasingly consistent in relation to one another as they age (32).

Methodologically, the same measure of a characteristic applied at different times yields higher stability estimates of the characteristic, whereas different measures yield lower stability estimates (minimally on account of method variance; 33): Switching from maternal report at 2 years to testing methodology at 5 years attenuates stability of child language between those time points (7). Some measures (e.g., self-report) tend to show higher stability than other measures (e.g., observation; 34, 35). The shorter the inter-assessment interval, the greater the likelihood of continuity and stability (the Guttman "simplex"; 36). However, parameters matter: If change is rapid in a characteristic, even a short inter-assessment interval may last too long to reveal consistency. (Notably, the duration of the inter-assessment interval has implications for distinguishing "reliability" from "stability", a temporal distinction that may be construct- and theory-dependent and is also nowhere clearly or adequately drawn in the psychometric literature.) Likewise, consistent assessment settings promote, and inconsistent ones attenuate, continuity and stability (34, 35).

Finally, consistency is theory sensitive: In the view of some, continuity and stability are unlikely in at-risk samples due to their poverty and chaotic and changing environmental circumstances, whereas in the view of others, risk is associated with rigidity and inflexibility ensuring continuity and stability (7, 37).

In short, consistency and change are contingent, not absolute, underscoring the need to attend to moderation in each.

Implications and Challenges of Continuity and Stability

Characterizing continuity and stability does not paint a complete developmental picture. Lerner et al. (3) observed that in stability and in instability a given individual's relative position in a group is paradoxically uninformative about whether actual within-person change has taken place. A child (C2 in Figure 3C) can change in mean level of language, and the change may still be labeled stability if other children also change and if the target child keeps the same relative position. This possibility alone is good reason for developmental scientists to regularly distinguish and report continuity *and* stability. By contrast, a child could remain at the same level from time 1 to time 2, yet his or her position could be unstable relative to peers if other children in the group changed while the target child did not (C2 in Figure 3D). Continuity and stability are relative, not absolute, and interpreting one without the other risks misinterpreting development.

Although fundamental, continuity and stability pose several other unique challenges to interpretation. Changes in mean level or in individual order over short periods of time, other things being equal, can indicate that characteristics are genuinely sensitive to temporal aspects of development or simply fail to capture continuous and stable qualities. Over the longer term, it is sometimes tricky to know when to attribute change to inadequate measurement (38), to varying contexts, to real development, to practice and familiarity, or to interactive developmental processes. Likewise, continuity (Figure 1A) and instability (Figure 2B), which are both developmentally meaningful concepts, both predict the null – respectively, a nonsignificant mean difference and a correlation not different from zero. The two therefore constitute intractable logical, methodological, and statistical conundra.

Finally, the constructs of consistency and change are inherently ambiguous as to their meaning, and each subject to contextual interpretations. Consistency in a characteristic may be a sign of resilience *or* inflexibility, and change in a characteristic may be a sign of flexibility *or* disorganization. Many different systems strive to maintain a state of dynamic and adaptive equilibrium, and consistency often signals robustness and health. At the same time, many systems naturally change through growth and adaptation to support optimal functioning. However, some kinds of inconsistency and change herald disorder, illness, and even death. The absence of language is a sign of some forms of autism spectrum disorder (ASD; 39), and loss of language (aphasia) is an indicator of dementia (40). Characteristics are meaningful in development when they are consistent *and* when they change.

Human beings exhibit important consistencies throughout the life course, but the lifespan perspective on human development specifies that human beings are also open systems and so

the flexible nature of many characteristics ensures that people change as well. Focusing solely on change leads to the view that development may be progressive (or regressive) or to the narrow perspective that development may be disorderly; alternatively, focusing on consistency alone renders development more comprehensible, but risks viewing ontogeny as fixed and overlooks potentialities and realities of meaningful change. Consistency and change are equally central in development and equally vital to the descriptive, explanatory, predictive, and optimizing goals of the project of developmental science. Yielding to the tension between these two omnipresent, intrinsic, and potent dynamics in our science is thought provoking, and the thoughts that it provokes challenge, seduce, and gratify in equal measure.

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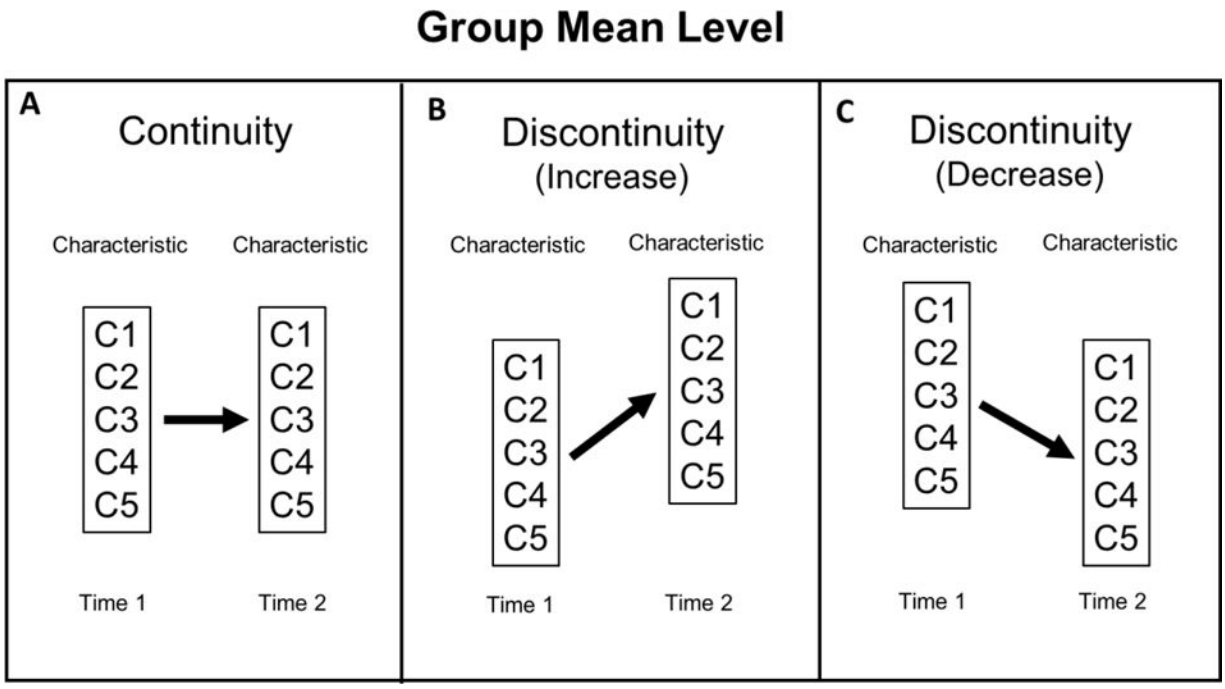

Figure 1. Group mean level continuity and discontinuity

Note. C1-C5 are individual children measured on a characteristic at two time points.

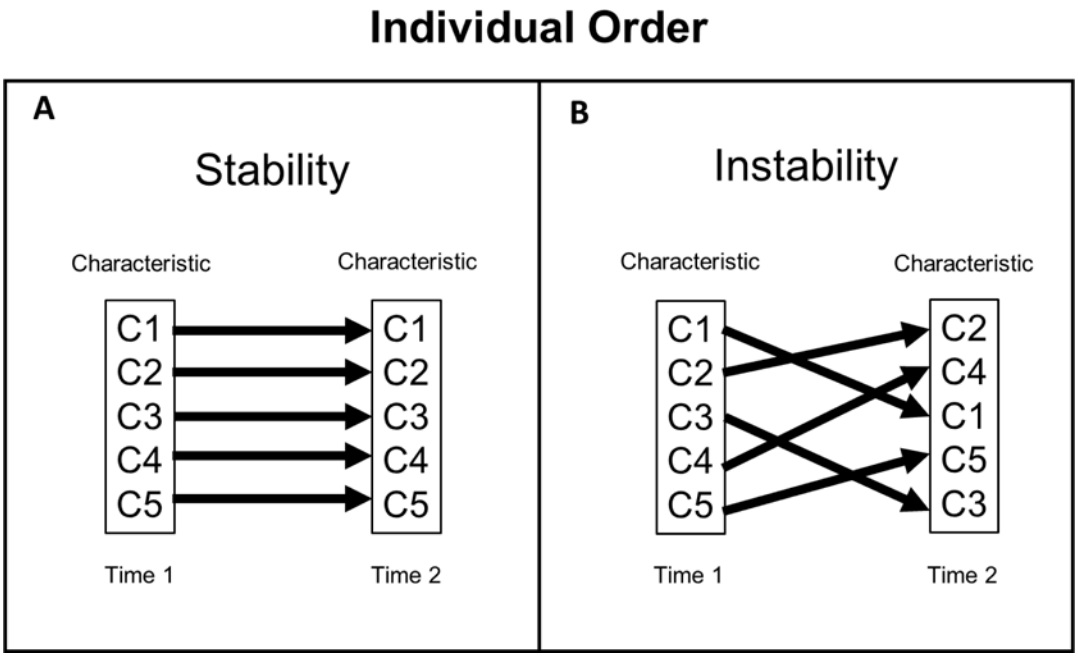

Figure 2. Individual order stability and instability

Note. C1-C5 are individual children measured on a characteristic at two time points.

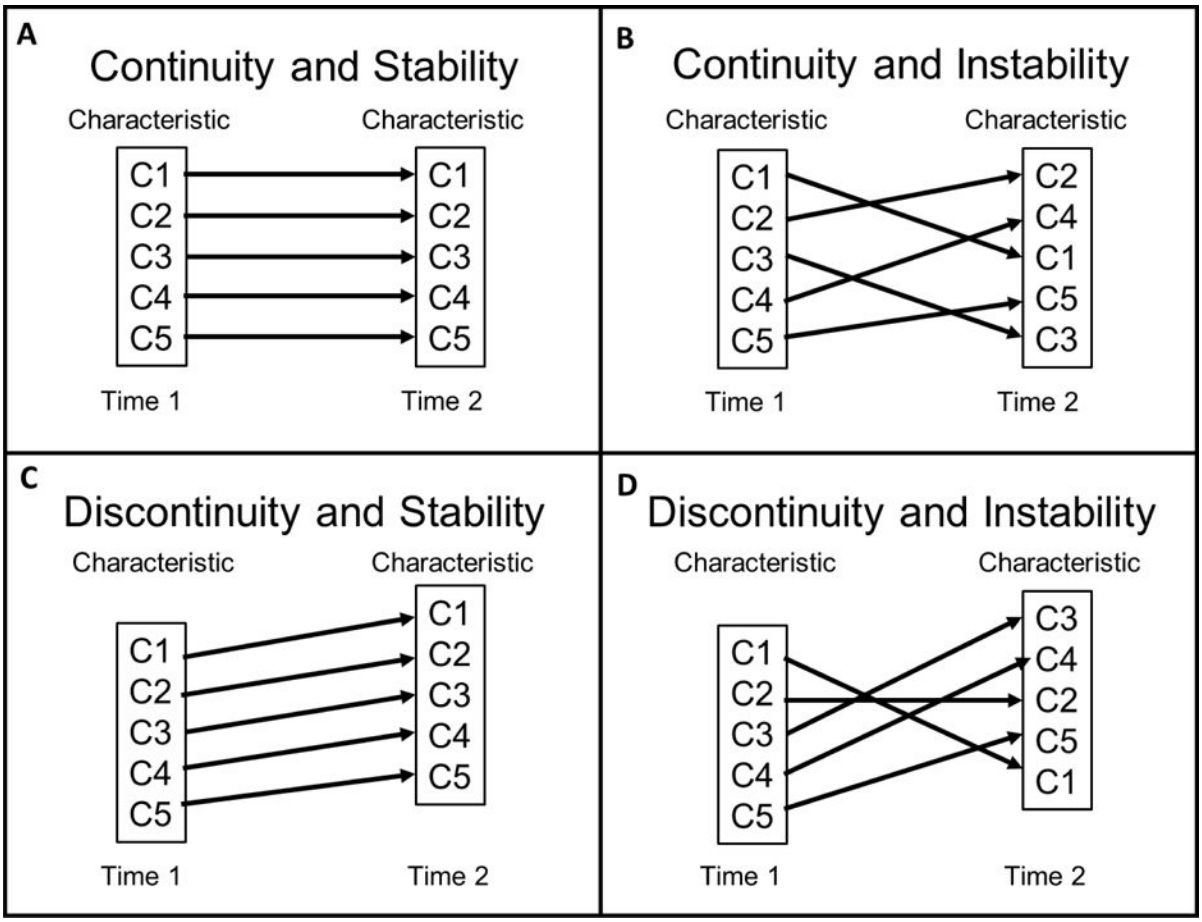

Figure 3. Four profiles of development

Note. C1-C5 are individual children measured on a characteristic at two time points.

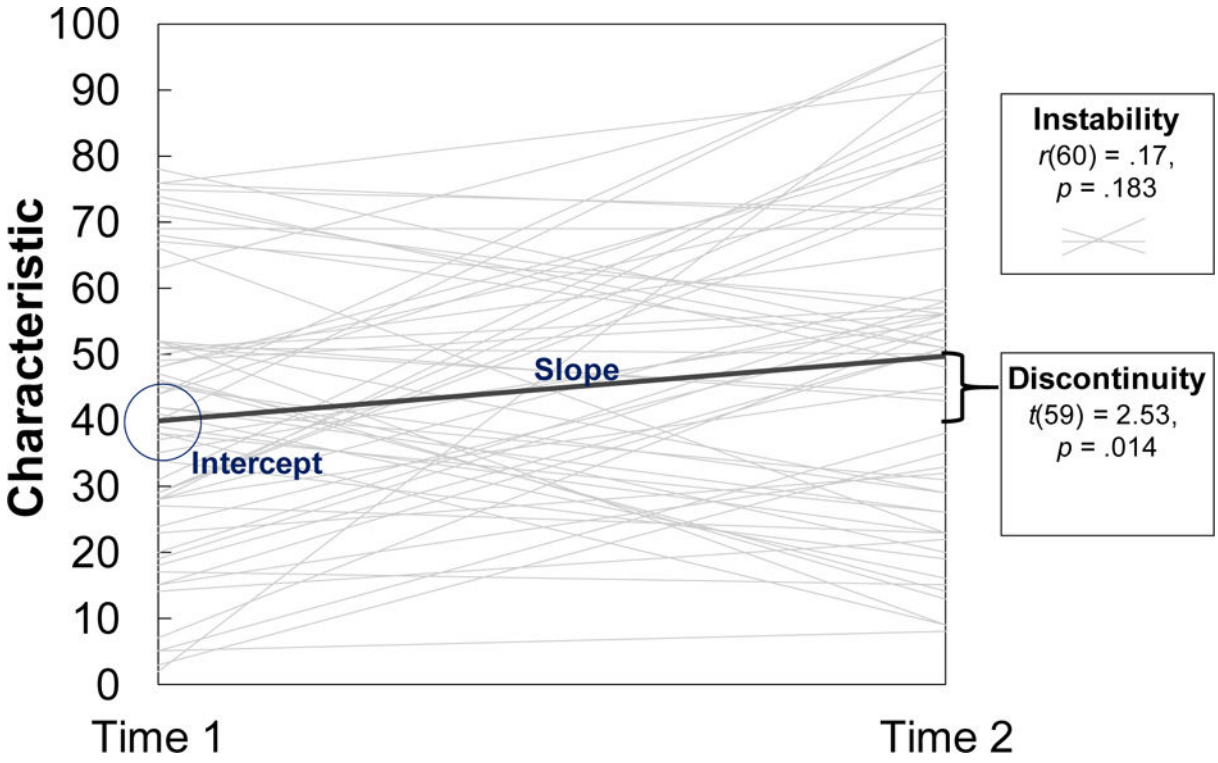

Figure 4. Trajectories of development: How the intercept and slope differ from continuity and stability

Note. Gray lines represent individual child changes in ability from time 1 to time 2. The intercept is the group mean level at time 1. The slope is the average rate of change from time 1 to time 2. Stability is the degree to which children maintain their rank order from time 1 to time 2. Continuity is the change in group average from time 1 to time 2.