

Patterns of Gender Development

Carol Lynn Martin¹ and Diane N. Ruble²

¹Arizona State University, School of Social and Family Dynamics, Program in Family and Human Development, Tempe, Arizona 85287-3701; email: cmartin@asu.edu

²Department of Psychology, New York University, New York, New York 10003; email: diane.ruble@nyu.edu

Annu. Rev. Psychol. 2009. 61:353–81

The *Annual Review of Psychology* is online at psych.annualreviews.org

This article's doi:
10.1146/annurev.psych.093008.100511

Copyright © 2009 by Annual Reviews.
All rights reserved

0066-4308/09/0110-0353\$20.00

Key Words

gender typing, stereotypes, dynamic systems, sex segregation, timescales

Abstract

A comprehensive theory of gender development must describe and explain long-term developmental patterning and changes and how gender is experienced in the short term. This review considers multiple views on gender patterning, illustrated with contemporary research. First, because developmental research involves understanding normative patterns of change with age, several theoretically important topics illustrate gender development: how children come to recognize gender distinctions and understand stereotypes, and the emergence of prejudice and sexism. Second, developmental researchers study the stability of individual differences over time, which elucidates developmental processes. We review stability in two domains—sex segregation and activities/interests. Finally, a new approach advances understanding of developmental patterns, based on dynamic systems theory. Dynamic systems theory is a metatheoretical framework for studying stability and change, which developed from the study of complex and nonlinear systems in physics and mathematics. Some major features and examples show how dynamic approaches have been and could be applied in studying gender development.

Contents

INTRODUCTION 354

HOW EARLY DO CHILDREN ACQUIRE GENDER CONCEPTS AND EXHIBIT PREJUDICE AND DISCRIMINATION? 355

 Do Infants Understand and Use Gender? 355

 When Do Children Develop Stereotypes? 356

 When Do Children Exhibit Prejudice and Discrimination? 357

HOW STABLE ARE INDIVIDUAL DIFFERENCES IN GENDER TYPING? 361

 Evidence of the Stability of Gender Typing from Longitudinal Studies 362

 Interpretations and Conclusions About the Evidence from Longitudinal Studies 365

HOW DOES THE STUDY OF GENDER DEVELOPMENT BENEFIT FROM DYNAMIC ANALYSES? 366

 Dynamics and Complex Systems: Basic Concepts 367

 Children's Play Choices: Sex Segregation as a Dynamic System 368

 Variability in Systems: Gender-Typed Activities, Sex Segregation, and Gender Identity 369

 Dynamic Contexts: Gender Cognitions and Socialization 371

 Methods and Analyses of Dynamic Systems 371

 Dynamic Analyses of Gendered Play Partners and Activities 372

CONCLUSIONS 374

INTRODUCTION

Understanding the changes that correspond with the passage of time is a hallmark of developmental studies, including the study of gender development. Gender developmental scientists are concerned with age-related changes in gender typing, and more broadly, with many issues about the emergence and patterning of gendered behaviors and thinking. Description of these changes is vitally important as it informs theoretical approaches to gender development. Using a broad lens on age-related changes provides important information describing how development occurs, but shorter time frames are also useful for identifying processes that may underlie developmental patterns. Gender developmental scientists are beginning to conceptualize temporal change and measurement of relevant variables over time in more nuanced ways and with new methods and analytic strategies.

Our goal in this article is not to provide an extensive review of changes in gender over childhood, but instead to focus on the perspective of developmental patterning. In selecting issues to review, we attempted to find a set of issues that would provide insights into processes underlying gender development while also being representative of contemporary issues and future directions in the field. First, to highlight developmentalists' interest in average or normative changes across age, we review the timeline of gender development for the emergence of gender understanding and stereotyping and how discrimination and prejudice develop in childhood. Second, we examine continuities within individuals over time as an important theoretical complement to the first focus on mean-level, normative patterns over time. Longitudinal studies are reviewed to examine whether individual differences are stable over time in two areas of gender typing: sex segregation and activities and interests. Finally, we discuss how dynamic systems theory may be applied in gender development and describe its

potential for understanding patterns over different time frames.

HOW EARLY DO CHILDREN ACQUIRE GENDER CONCEPTS AND EXHIBIT PREJUDICE AND DISCRIMINATION?

The first few years of life and into adolescence have been the focus of much theorizing and empirical research on gender development. Major questions have arisen about the timeline of gender development, and resolving these issues is central to understanding processes underlying gender development. In this section, we discuss two key aspects of gender development. First, the earliest emergence of gender understanding and behaviors provides insights about the origins of sex differences and the prominence of gender as a social category, and so it is not surprising that these topics have been highlighted in contemporary research on gender development. Second, because of the far-ranging implications for human social interactions, we review research evidence concerning the emergence of gender prejudice and discrimination.

Do Infants Understand and Use Gender?

A major issue that has driven research is whether children's basic understanding of gender identity motivates and organizes the development of gender-typed behaviors, an idea proposed by "self-socialization" theories of gender development. Self-socialization perspectives posit that children actively seek information about what gender means and how it applies to them and that an understanding of gender categories motivates behavior such that, in essence, they socialize themselves (see Martin et al. 2002). In contrast, others (Bussey & Bandura 1999, Campbell et al. 2002) have argued that gender understanding must not play an important role in the emergence of gendered behaviors because some gender-typed behaviors emerge prior to age two, presumably earlier than children's understanding or identification

with gender. The evidence needed to resolve this controversy concerns whether behavior becomes increasingly gender typed with the onset of basic gender understanding, and recent findings have extended our knowledge of these fundamental issues. Much has been written about these topics and about the surrounding controversies (Bandura & Bussey 2004; Martin et al. 2002, 2004); here, we provide an overview and update of the evidence.

When do children begin to recognize that there are two types of people—males and females—and when are they able to link this information to other qualities to form basic stereotypes? A related question is, when do children recognize their own sex? Infants as young as three to four months of age distinguish between categories of female and male faces, as demonstrated in habituation and preferential looking paradigms (Quinn et al. 2002). By about six months, infants can discriminate faces and voices by sex, habituate to faces of both sexes, and make intermodal associations between faces and voices (e.g., Fagan & Singer 1979, Miller 1983, Younger & Fearing 1999). By 10 months, infants are able to form stereotypic associations between faces of women and men and gender-typed objects (e.g., a scarf, a hammer), suggesting that they have the capacity to form primitive stereotypes (Levy & Haaf 1994). Infants' early associative networks about the sexes may not carry the same conceptual or affective associations that characterize those of older children or adults, although the nature of these associations has yet to be examined in any depth (see Martin et al. 2002).

Because of the difficulties associated with testing infants, it has been challenging to determine when children first recognize their own or others' sex. Early studies suggested that labeling and understanding of gender may not emerge until about 30 months of age, but more recent studies have moved the age of understanding gender identity and labeling downward. In a study using a preferential looking paradigm, about 50% of 18-month-old girls showed knowledge of gender labels ("lady," "man"), but boys did not, and 50% of

18- and 24-month-old boys and girls showed above-chance understanding of the label “boy” (Poulin-Dubois et al. 1998). In another non-verbal testing situation, 24- and 30-month old children knew the gender groups to which they and others belonged (Stennes et al. 2005). Similarly, most 24- and 28-month-old children select the correct picture in response to gender labels provided by an experimenter (Campbell et al. 2002, Levy 1999).

A recent study examined the naturally occurring instances of gender labels (e.g., girl, boy, woman, man, lady, guy) as indicators of knowledge of gender categories and assessed whether the onset of use of these terms related to children’s observed free play with toys (Zosuls et al. 2009). Information about gender labels was obtained from examining bi-weekly parent diaries of children’s speech from 10 months of age onward. Zosuls and colleagues (2009) also analyzed videotapes of the children at 17 months and 21 months playing with a set of toys varying from high to neutral in gender typing. The results showed that 25% of children used gender labels by 17 months and 68% by 21 months. On average, girls produced labels at 18 months, one month earlier than did boys. These labeling results were used to predict changes in gender-typed behavior with the two most strongly gender-typed toys (trucks and dolls). Children who knew and used gender labels were more likely than other children to show increases in gender-typed play with toys.

Taken together, these studies suggest that most children develop the ability to label gender groups and to use gender labels in their speech between 18 and 24 months. As proposed by self-socialization theorists, the results from the Zosuls et al. study (2009) suggest that developing this ability has consequences: Knowing basic gender information was related to increased play with strongly stereotyped toys. These findings are consistent with research suggesting that children develop awareness of their own “self” at roughly 18 months and then begin to actively engage in information seeking about what things mean and how they should behave (Baldwin & Moses 1996).

When Do Children Develop Stereotypes?

Developmental researchers have identified that rudimentary stereotypes develop by about two years of age (Kuhn et al. 1978), and many children develop basic stereotypes by age three (Signorella et al. 1993). Children first show an understanding of sex differences associated with adult possessions (e.g., shirt and tie), physical appearance, roles, toys, and activities, and recognize some abstract associations with gender (e.g., hardness as male; softness as female) (Leinbach et al. 1997, Weinraub et al. 1984). Children develop stereotypes about physical aggression at an early age, and by age 4½, children believe that girls show more relational aggression than boys (Giles & Heyman 2005). Interestingly, even when researchers examine children’s spontaneous associations about boys and girls, a consistent pattern is found from preschool through fourth/fifth grade: girls are seen as nice, wearing dresses, and liking dolls, and boys are seen as having short hair, playing active games, and being rough (Miller et al. 2009).

As children grow older, the range of stereotypes about sports, occupations, school tasks, and adult roles expands, and the nature of the associations becomes more sophisticated (e.g., Sinno & Killen 2009). Specifically, early in childhood, children make vertical associations between the category label (“girls,” “boys”) and qualities (e.g., “boys like trucks”). They appear slower to make horizontal inferences (e.g., recognizing that trucks and airplanes are associated with being “masculine”), which tend to appear around age eight. For instance, when told about an unfamiliar sex-unspecified child who likes trucks, older children but not younger ones predict that the child also likes playing with airplanes (Martin et al. 1990). Concreteness of gendered items influences the ability of younger children to make these property-to-property inferences (Bauer et al. 1998). In contrast, adults often rely on individuating information rather than the person’s sex to make similar types of judgments (Deaux & Lewis 1984). The

difficulty that children have with these judgments suggests that they may not understand within-sex individual differences.

Meta-analytic studies find that stereotypes become more flexible with age (Signorella et al. 1993). A longitudinal study of children from 5 to 10 years of age showed a peak in the rigidity of stereotypes at either 5 or 6 years of age and then an increase in flexibility two years later. Neither the timing nor the level of peak rigidity affected the developmental trajectory, suggesting that children generally follow the same normative path across development despite variations in when rigidity starts and how extreme it becomes (Trautner et al. 2005).

Many questions remain to be answered about the developmental progression in learning the content of stereotypes and in exploring individual differences in patterns of development. For instance, when do children first begin to assume that there are similarities within one sex and dissimilarities between the sexes? Theorists are interested in examining the roles that personal interests and idiosyncratic knowledge play in the development or hindrance in stereotype formation (Liben & Bigler 2002, Martin & Ruble 2004). Furthermore, how children apply stereotypes once they have learned them is an issue of continuing interest in the field.

When Do Children Exhibit Prejudice and Discrimination?

Recent conceptual analyses suggest a range of factors that likely contribute to the development of stereotypes and prejudice, such as highly salient categorizing dimensions (e.g., sex) (Martin & Ruble 2004) and labeling of these dimensions by others (Bigler et al. 1997). Because recent reviews of Developmental Intergroup Theory have covered the influence of these factors and discussed studies of children's responses to novel stereotyping situations (Arthur et al. 2008, Bigler & Liben 2007), the focus here is on the age-related changes in cognitive and behavioral expressions of gender prejudice and discrimination, not with their origins.

Attitudes about the two sexes. How do children's evaluations of the two sexes change with age? This question involves a number of different kinds of attitudes and beliefs; we focus on two: (a) ingroup/outgroup biases, and (b) perceptions of status differences and discrimination. There has been relatively little research on these topics, but interest has increased recently.

Ingroup/outgroup biases. Children's growing awareness of membership in a social group (i.e., male or female) becomes an evaluative process through self-identification and thus affects how positively children regard the ingroup relative to the outgroup (Ruble et al. 2004). Some research suggests that as early as preschool, children report feeling more positively about their own sex (Yee & Brown 1994), and differential liking is also seen among older children (e.g., Heyman 2001, Verkuyten & Thijs 2001). Studies are mixed regarding age trends, depending on the measure. Those examining negative versus positive trait ratings suggest that intergroup biases decline in elementary school (e.g., Egan & Perry 2001, Powlisha et al. 1994), consistent with increasing stereotype flexibility described above; but studies tapping more affective reactions (e.g., liking the ingroup better) do not show this decline (e.g., Yee & Brown 1994), at least not until early adolescence (Verkuyten & Thijs 2001).

We do not yet know whether and when ingroup favoritism is associated with outgroup derogation. That is, do children actually dislike or have hostile attitudes toward the other sex, or is it simply that children like their own sex better? Because many studies use difference scores, ingroup positivity and outgroup negativity are often confounded (Brewer 2001, Cameron et al. 2001). Moreover, Kowalski (2007) reports that studies of young children's interactions do involve evaluative comments between boys and girls but rarely involve animosity, suggesting that some researchers may have misinterpreted children's positive ingroup feelings in structured interviews as overt rejection of the other group. Recent research suggests that when they are decoupled, ingroup positivity effects are

stronger than outgroup negativity among elementary school children (Susskind & Hodges 2007). It is also not clear whether young girls' willingness to judge boys as "bad," for example, indicates outright hostility (Rudman & Glick 2008) or if, instead, such judgments reflect stereotypes about boys getting into trouble (e.g., Heyman 2001). On the other hand, studies showing that the other sex is disliked (e.g., Yee & Brown 1994) are consistent with a conclusion of negative outgroup evaluation. An important issue for future research concerns this distinction between cognitive and affective aspects of intergroup bias and its connection to the development of gender prejudice (Halim & Ruble 2009).

A distinction in the adult literature between hostile and benevolent sexism (Glick & Fiske 2001) represents a potentially very useful conceptualization for future developmental research. The idea is that, unlike most forms of prejudice toward outgroups, negative intergroup attitudes between males and females are likely to be complicated by intimate interdependence and thus are likely to be ambivalent, involving benevolent as well as hostile aspects. For example, women may be viewed as competitors seeking to gain power over men, but they may also be viewed as angelic (put on a pedestal) and vulnerable, in need of protection. Men may be resented for their dominance over women but also admired as providers and heroes. Applying this distinction to the developmental course of intergroup attitudes, Rudman & Glick (2008) argued that ambivalence does not characterize gender prejudice in young children, but rather that it moves from a simple form of childhood hostility toward competing groups to ambivalent sexism.

This is an interesting proposal with important implications, but questions remain. First, outgroup negativity in young children can be interpreted differently, as suggested above; their perceptions may be simple and competitive, but not extreme enough to be characterized as hostile. Perhaps, instead, children's need to master important categorical distinctions coupled with relatively limited cognitive

skills make it threatening when peers cross gender boundaries (Kowalski 2007). Second, young children's attitudes may involve some complexity and ambivalence, but of a different sort than for adults. For example, young children may dislike members of the other sex because they are boring (about girls) or rough (about boys) while still holding positive views about other characteristics of other-sex peers, such as girls are nice and boys play exciting games. Moreover, children begin to anticipate adult roles at an early age, and benevolent feelings could arise from a "princess" anticipating her "prince" or the expectation by two young opposite-sex friends that they will one day be husband and wife. Further examination of different interpretations of preschoolers' ingroup bias is important because knowing what it represents is critical to knowing when to intervene to minimize sexism.

Awareness of status differences and discrimination. When do children become aware of the status difference applied to males and masculine activities relative to females and feminine activities in most cultures? Although studies of gender stereotypes in young children show that they attribute greater power to males and helplessness to females (Ruble et al. 2006), only a few studies have examined perceptions of inequality directly. First, research has found awareness of status differences in occupations typically held by men and women (Liben et al. 2001, Teig & Susskind 2008). Children as young as 6 years understood that jobs more likely to be held by men (e.g., business executive) are higher in status than female-typical jobs, but only older children (11-year-olds) associated fictitious "male" jobs as being higher in status (Liben et al. 2001). A study of perceptions of a high-status job—the U.S. presidency—found that 87% of children aged 5–10 years knew that only men had been presidents, though knowledge increased significantly with age (Bigler et al. 2008).

Second, research has examined the development of children's general perceptions of gender inequalities (Neff et al. 2007). The

findings showed a notable increase between 7 and 15 years of age in beliefs that males are granted more power and respect than females.

Finally, a few recent studies examined children's perceptions of gender discrimination. First, in the study of the presidency, only approximately 30% of the 5- to 10-year-old children attributed the lack of women presidents to discrimination, although this percentage increased with age. Instead, the most frequent explanation was ingroup bias: that men would not vote for women. These findings suggest that even young children are aware of how ingroup biases shape behavior and that they perceive such reasons as more important than institutional discrimination in determining the selection of the president (Bigler et al. 2008). In a second study, children in two age groups (5–7 and 8–10 years) responded to a set of hypothetical stories about teachers deciding whether a boy or a girl did better on an activity (Brown & Bigler 2005). The findings showed that the younger children were somewhat aware of gender discrimination, but such perceptions were higher in the older group. Children perceived discrimination, however, only when explicitly told that the teacher may be biased, not when the context was ambiguous.

Taken together, these studies suggest that children's awareness of the differential status of the sexes and gender discrimination are relatively late-developing phenomena. Young children show limited awareness, but only when contextual cues (e.g., explicit mention of biases) or social experiences (knowledge of status of real occupations) make inequities obvious. More subtle awareness of inequities may not emerge until later in elementary school. The slow development of this more "public" evaluation, such as recognizing status and power differences and institutional discrimination, is in stark contrast to the early developing "personal" regard shown by ingroup biases, suggesting different developmental underpinnings of the two types.

Gender prejudice and discrimination. In what ways might developmental changes in

stereotypic beliefs and intergroup attitudes play out in actual choices and behavior? What little research there is on gender prejudice development has primarily focused on two types: (a) negative reactions to peers' violations of gender norms and (b) preferential treatment.

Reactions to gender norm violations. Because preschoolers have strong beliefs that boys and girls do different things, they would be expected to respond negatively to gender norm violations. Several early studies found support for this prediction (Huston 1983). For example, when 3- to 5-year-olds were videotaped while playing with either a male- or female-typed toy (e.g., soldiers; dollhouse) in the presence of a same-sex peer, children were punished (e.g., ridiculed) by the peer when playing with cross-sex toys (Langlois & Downs 1980).

Recent research has supported and expanded these findings. For example, teachers report that kindergarten children tend to respond in one of three ways to gender norm violations: correction ("give that girl puppet to a girl"), ridicule, and "identity negation" (e.g., "Jeff is a girl") (Kowalski 2007). Interestingly, one recent study found that preschool children are able to identify children who are more likely to enforce the gender rules and gender-segregated boundaries (McGuire et al. 2007). Preschoolers were asked, "Who in your classroom says you shouldn't play because you are a boy/girl?" The findings showed that children who had greater exposure to "gender enforcer" peers were more likely to limit their play to same-sex peers. These findings suggest that there may be individual differences in overt "sexist" behavior as early as preschool, and that the actions of these gender "police" contribute more broadly to the maintenance of gender distinctions in the classroom.

Because children show age-related increases in the flexibility of stereotypes and other aspects of gender category knowledge, such as gender constancy and the ability to make multiple classifications, their negative reactions to gender norm violations should decline after preschool. Unfortunately, age trends in older

children have received little attention, though examples of such behavior abound. Based on extensive qualitative ethnographic observations in middle-elementary school, Thorne (1993) found that boys who violated norms for masculinity were teased, shunned, or referred to as “girls.” For example, one girl excluded a boy from jump rope because “. . .you don’t know how to do it, to swing it. You gotta be a girl” (p. 45). Other research documented the various “rules” that children have about maintaining gender boundaries and found that children who maintain boundaries are more popular with peers (Sroufe et al. 1993). Finally, research with children exhibiting extreme gender-nonnormative behaviors suggests that girls and especially boys are teased and rejected by peers (Zucker & Bradley 1995).

Studies using hypothetical stories also indicate that children make negative judgments of, and consider unpopular, peers who engage in gender-atypical behavior, especially boys. In contrast to the implications from the more behavioral studies described above, however, many of these studies fail to find negative evaluations of gender-atypical behaviors before middle-elementary school (e.g., Berndt & Heller 1986), and children often show increased negativity with age, although findings are mixed (Ruble et al. 2006). The findings in the judgment studies may be influenced by the qualities and salience of the stimuli as well as by children’s cognitive abilities and gender knowledge (Arthur et al. 2008, Lutz & Ruble 1995). For example, one recent study showed a dramatic decrease in negative judgments between 5 and 7 years of age, which was mediated by increasing gender knowledge—specifically, gender constancy (Ruble et al. 2007b).

Thus, conclusions about evidence of sexism in young children drawn from judgment studies can be different from conclusions drawn from studies of actual behaviors. This observation raises interesting questions for future research about what exactly children are reacting to when they demonstrate seemingly sexist behaviors or attitudes toward peers engaging in atypical behavior. First, children’s liking or

popularity judgments in hypothetical situations may reflect egocentric considerations, such as preferring targets engaged in activities typical of their own sex (e.g., girls preferring male targets with feminine interests) (Alexander & Hines 1994, Zucker et al. 1995). Thus, young children’s liking for gender nonconforming targets may not reflect their tolerance for gender nonconformity but instead their personal interest in masculine or feminine activities.

Second, it is not clear if the sexist behaviors found in preschool children (e.g., hitting a boy who wears fingernail polish) are based on global negative evaluations of such children as being gender atypical or if they reflect a more limited evaluation of a specific instance of a child breaking a rule (such as stealing cookies). Children’s judgments of gender atypicality are likely influenced by additional factors such as their perceptions of the targets’ dissimilarity to same-sex others (e.g., Egan & Perry 2001) and/or awareness of within-sex variability. Moreover, it may be only when children begin to recognize and understand the stability of behavior that individual atypical behaviors coalesce into a broader and more negative view of the person as being deviant (Ruble & Dweck 1995). Unfortunately, developmental changes in children’s perceptions of others’ gender typicality have received little attention. This is surprising because perceptions of gender typicality are key to understanding reactions to gender norm violations and what they mean. Whether preschoolers’ negative judgments and reactions reflect sexism and, if so, what form of sexism are interesting questions for future research.

Preferential treatment. Given that the in-group liking bias occurs at a young age, one might expect that children would show favoritism toward their own sex. When affiliative behavior is measured, children begin to show preferential selection of same-sex peers starting at age 3 (La Freniere et al. 1984). Children also preferentially allocate resources to their own-sex group, beginning in preschool (Yee & Brown 1994).

Other research has examined ingroup favoritism in terms of children's responses to hypothetical stories about excluding peers from gender stereotypic activities, such as a ballet or baseball "club" (Killen et al. 2008). In these studies, there has been little evidence that children were more likely to choose same-sex members. Instead, children's exclusion and inclusion decisions were found to vary across age depending on exactly what they were told about the situation. When children were asked about a single child who wanted to join the club, most children responded that exclusion was wrong (e.g., to exclude a boy from a ballet club), even though they knew the stereotypes. Consistent with findings of increasing flexibility of stereotypes with age, however, this was true for only about 60% of preschoolers (Theimer et al. 2001) versus 90% of older children (Killen & Stangor 2001). When children were asked to select between a boy and a girl of equal competence, age differences in the influence of gender stereotypes on inclusion decisions appeared to be even stronger. Children in the study of preschoolers selected the stereotyped choice (e.g., the girl for the ballet class) (Theimer et al. 2001). Older children, however, preferred the counterstereotypic choice (Killen & Stangor, 2001) and offered justifications based on equal access (e.g., boys don't get a chance to take ballet). Such "fairness" considerations in inclusion decisions coupled with relatively low levels of exclusion are surprising in that they seem inconsistent with the observations of behavioral exclusion described above. Perhaps only a few children engage in exclusion (e.g., the "gender police"), or hypothetical situations might allow children to think instead of answering impulsively and thus may not invoke ingroup favoritism as much as more personal, immediate situations might.

In short, it appears that gender prejudice and discrimination begin as early as preschool; this finding is particularly evident in research examining actual behavior, whether naturalistic or experimental. That is, preschoolers respond negatively to violations of gender norms and favor ingroup members in actual choices of

play partners (sex segregation) and allocation of resources. Findings of studies examining responses in hypothetical situations appear to be more mixed, however. From these studies, it appears that the form and bases of gender prejudice and discrimination vary across age and context. For example, in young children, prejudice may reflect simple same-sex liking biases or relatively straightforward applications of gender norms, whereas at older ages, prejudice may involve differential evaluation of capabilities and past history and thus be more closely linked to knowledge of status differences and discrimination. The few studies examining these issues have involved very different paradigms. Thus, findings that apparently conflict across studies cannot be evaluated without future research.

HOW STABLE ARE INDIVIDUAL DIFFERENCES IN GENDER TYPING?

It seems intuitively obvious that individuals vary greatly in how gender typed they are. Some girls are extremely "girly" and refuse to go anywhere without wearing a dress, often pink and frilly, whereas other girls have no such interest and instead prefer playing ball with the boys. Some men can handle any kind of tool (except kitchen tools!), whereas others lack such mechanical facility. It is commonly assumed that attributes associated with being a typical male or female are seen early on, show at least some continuity across time, and influence personal preferences and behaviors throughout life.

How much empirical support is there for these assumptions? Maccoby (2002) has argued that there is not much. According to her analysis, this is because different manifestations of gender typing in childhood do not cohere and because there is considerable situational variation in how gender typed a given child seems. Instead, she suggests that gender typing at this age may be more of a group phenomenon rather than something that reflects the dispositions of relatively more or less gender-typed children. Thus, she advocates a shift in research

focus away from individual differences in gender-related outcomes and toward the study of how gender is manifested in groups of males and females.

Although we agree wholeheartedly about the importance of studying group-based elements of gender, we suggest that it may be premature to dismiss the importance of examining gender typing as an individual difference variable. Variation across contexts and domains of gender typing does not preclude the possibility that some aspects show stability across time within individuals. For example, some boys may show an interest in moving parts or vehicles that persists in different forms into adulthood, even if that interest shows no connection to rough-and-tumble play or to other male-typical interests and behaviors. Surprisingly, researchers have rarely directly examined the stability of gender-typed interests and behaviors, and the existing database is piecemeal and sketchy (Huston 1983, Powlishta et al. 1993). This is unfortunate, because knowing more about which aspects of gender typing are stable is critical to a full understanding of the nature and processes involved in gender development.

In the sections below, we provide a detailed analysis of longitudinal studies of gender typing in children and what the studies show about stability. We then reevaluate the evidence that led to Maccoby's (2002) conclusions that examining individual differences in gender typing is not productive.

Evidence of the Stability of Gender Typing from Longitudinal Studies

What do longitudinal studies of gender development tell us about stability? Although gender typing can involve a number of different features, we limit the present review to behavioral-type variables (e.g., play with same-sex peers; interests and activities) rather than cognitive-type variables such as stereotyping or gender identity. We do this because much research on gender typing has concerned young children's peer and activity preferences. It is also partly

because cognitive variables show considerable variation during childhood (Ruble et al. 2006) and may not be conducive to demonstrating stability, at least in young children.

Surprisingly, the few longitudinal studies of gender typing that exist have paid relatively little attention to this issue of stability. This may be partly because it has not been a primary component of major theories of gender development. Because most theories emphasize the factors that lead to gender typing, longitudinal studies have often focused on such issues as how contextual, socialization, or social-cognitive factors at one point in time affect gender-typing at a later point in time (e.g., McHale et al. 2004) rather than on the stability of gender typing across time. Other longitudinal studies have focused on normative changes in gender-typed behaviors or cognitions, such as attitudes or stereotyping (e.g., Bartini 2006).

In interpreting the theoretical significance of such studies, however, it is essential to determine whether gender typing represents some continuing characteristic of individuals that influences future beliefs and behaviors or whether it is better viewed as linked to a particular developmental time point or context, with little future implications (Serbin et al. 1993). Moreover, identifying the factors that lead children to be more or less gender typed should help distinguish among alternative theories of gender typing (Powlishta et al. 1993). Thus, information about which elements of gender typing are stable, over what period of time, and during which developmental periods seems essential to the study of gender development.

Longitudinal studies examining the stability of sex segregation. Some studies have used observational methods to examine the stability of preferences for spending time with same-sex versus other-sex others. Different types of assessments have been used: (a) split-half correlations (e.g., across odd versus even weeks), (b) cross-situational stability (e.g., across indoor and outdoor play); and (c) test-retest (temporal) stability (whether sex segregation scores are correlated over some period of time).

The findings have been mixed, both across studies and across measures, and most studies have involved small samples and relatively short time periods (six months or less). To illustrate, Maccoby & Jacklin (1987) reported nonsignificant test-retest reliability over a one-week period among 4½-year-olds (0.39) and among 6½-year-olds (0.17). They did find cross-situational (indoor-outdoor) stability in preschoolers, but for girls only (0.44). Powlisha et al. (1993) used a split-half reliability procedure across odd and even days over a four- to six-month period and found that sex segregation showed significant stability for preschool boys (0.73) but not for girls (0.20). Lloyd & Duveen (1992) found significant temporal stability (0.40) in children ranging in age from about 4 to 7 years when they correlated the proportion of same-sex play from one term to the next. Turner et al. (1993) also examined temporal stability in a large sample ($n = 161$) of 4- to 4½-year-old children from two countries across eight sessions. Sex segregation scores in sessions one to four were correlated with sessions five to eight at significant or marginal levels (0.3 to 0.7).

As a final example of studies examining relatively short-term stability, Martin & Fabes (2001) assessed sex segregation over two consecutive academic terms for preschool and kindergarten children. Observations took place inside and outside every weekday for six months. This study is unusual because of the large number of observations (about 300 per child) and because of the use of multiple forms of stability assessment. First, split-half procedures (odd and even weeks) showed high and significant correlations for both sexes and for younger and older children (0.69–0.84). Second, as suggested by Epstein (1980), they calculated stability coefficients with data aggregated over differing lengths of time, a procedure that reduces error of measurement. The one-week coefficients were low (below 0.3), but as the number of weeks of aggregated data increased, the stability coefficients showed large increases, such that when data were aggregated over eight-week periods, stability coefficients

rose to the 0.5 to 0.6 range and continued to rise across larger units of time. Finally, they found considerable temporal stability (>0.7) across the two academic terms. These findings suggest that a relatively large number of observations, spread over time, may be needed to observe stability in sex segregation. Thus, prior conclusions about a lack of individual stability in same-sex peer preferences may be misleading.

In short, some longitudinal studies show reasonably impressive stability of individual differences in sex segregation. One problem with these studies, however, is that stability is examined within a group context that does not change. That is, stability may be found not because of individual differences in same-sex preferences, but rather because groups are formed early in the class year, and these structures are maintained (Maccoby & Jacklin 1987). Thus, the results of longitudinal studies involving longer periods of time are of considerable interest.

Unfortunately, few studies have examined temporal stability for longer than six months, and, as with short-duration research, the findings are mixed. For example, Maccoby & Jacklin (1987) examined stability in sex segregation in children across a two-year period (4½ to 6½ years). Given the low level of short-term stability found in this study, as described above, the authors did not expect to find, and did not find, much evidence of temporal stability, except for a significant correlation (0.31) over time for boys, but only for outdoor play. In contrast, Serbin et al. (1993) did find long-term temporal stability from one year to the next using a peer-nomination procedure (e.g., participants selecting photos of the children with whom they most like to play) in 5- to 12-year-olds. It is not clear exactly why this paper-and-pencil measure might yield more stable estimates, but it may be that the situational variation in observations was eliminated and that only the strongest relationships were assessed this way. Regardless, it is impressive that temporal stability was found across a time period when classrooms had changed.

Taken together, despite some nonsignificant findings, it seems fair to conclude that individual differences in sex segregation do show both internal consistency (split-half reliability) and temporal stability, given sufficient power and numbers of observations. Although observational data suggest that a child may vary in same-sex play from week to week, when observations are aggregated across multiple weeks, stability is seen. It would be helpful in future research to use data-aggregation procedures to see how many weeks of observations are needed to show temporal stability across one year or more. It would also be worthwhile to examine how long individual differences in segregation are maintained. For example, do preschool preferences predict preferences in middle-elementary school?

Longitudinal studies of the stability of interests and activity preferences. Studies of other indices of gender typing have been somewhat more consistent in finding temporal stability. Some observational studies of preschoolers and/or kindergartners have shown short-term, test-retest temporal stability in stereotyped toy and activity choices during free play (e.g., Maccoby & Jacklin, 1987, Martin & Fabes 2001). Other observational studies have shown significant stability in terms of split-half consistency (e.g., Connor & Serbin 1977, Powlisha et al. 1993). In addition, gender-stereotyped activity preferences have shown moderate to high stability over varying periods of time, as assessed with test-retest reliability involving pencil-and-paper measures completed either by the children themselves (e.g., Edelbrock & Sugawara 1978, Golombok & Rust 1993) or by parents about their children (e.g., Golombok & Rust 1993).

One recent, impressive study examined the stability of gender typing using pencil-and-paper measures (Golombok et al. 2008). This study warrants a more detailed look because it involved a much longer time period (from age 2½ to 8 years) and a much larger sample (more than 2700 girls and 2700 boys) than has been typical. When the children were ages 2½, 3½,

and 5 years old, parents completed a toy and activity questionnaire (Pre-School Activities Inventory, or PSAI; Golombok & Rust 1993) about their child's preferences; at age 8, the children completed an age-appropriate modified version, the Children's Activities Inventory (CAI). To examine temporal stability during the preschool years (test-retest reliability), intercorrelations in PSAI scores were examined among all three time points (ages 2½, 3½, and 5 years). Stability coefficients for the PSAI were high: 0.6–0.7 for adjacent time points and 0.5 from 2½ to 5 years. These levels are comparable to or even higher than those reported in earlier studies and thus demonstrate moderate to high stability in gender-typed interests and activities over time periods ranging from 1 to 2½ years.

Golombok et al. (2008) also examined stability between the preschool years and age 8, though not with test-retest correlations. Instead, at age 3½, boys and girls separately were divided into nine categories of gender typing based on PSAI scores; children who varied in their categories were compared on CAI scores. For both sexes, the children who were most gender typed at age 3½ continued to be so at age 8. A similar analysis compared CAI scores at age 8 with scores indicating the trajectory (acceleration in gender-typed interests) from ages 2½ to 5 years. As predicted, children showing the greatest increase in gender typing at a young age were those with higher levels of gender-typical behavior at age 8.

These findings are interesting in part because the trends run counter to what would be expected from regression to the mean, in that the children who were most gender typed to start with became relatively more so over time. Moreover, the findings suggested the possibility that individual differences in gender typing may be more stable in children who are relatively high or low in gender typing when young, a pattern that was particularly marked for the least gender-typed girls. It would be of great interest in future research to examine the stability and trajectory of gender typing among children at the extremes, such as tomboys or girly girls.

Taken together, longitudinal studies of gender-typed interests and activities show fairly compelling evidence of stability of individual differences. Future research needs to examine stability across one year or more using observations rather than paper-and-pencil measures to be certain that the apparent stability of gender typing reflects actual behaviors rather than stability in self- or parent perceptions.

Interpretations and Conclusions About the Evidence from Longitudinal Studies

As we discussed in the introduction to this section, Maccoby (2002) suggested that the study of individual differences in gender typing was no longer productive on the basis of various types of evidence, most notably: (a) the idea that sex typing is multidimensional and lacks coherence, and (b) the situational variability of gender typing. In our review of the longitudinal data, we identified some reasons why prior findings might have led to Maccoby's conclusions. Most importantly, the longitudinal studies suggest that a lack of power and insufficient reliability may have made it difficult to observe temporal stability within domains or coherence across domains. The case is particularly clear for studies of sex segregation. The studies of very short-term stability suggest that children do vary from day-to-day and week-to-week in the proportion of time spent with same- versus other-sex peers. Over greater numbers of data points and amounts of time, however, relative consistency of individual children can be seen (e.g., Martin & Fabes 2001). This observation also speaks to the apparent lack of coherence seen across different indices of gender typing. Indeed, when stable, reliable measures are used, coherence across indices is often observed (e.g., Martin & Fabes 2001, Serbin et al. 1993). In short, based on the findings reviewed, we conclude that the study of individual differences in gender typing may be more productive than has recently been thought. Nevertheless, we also urge caution: It would be unreasonable to conclude that gender typing is strong and

stable throughout life, because the database is limited in a number of ways.

First, it is not clear how long such differences remain stable. For example, gender-typed behavior is perhaps most visible in young children, when rigid distinctions appear in children's appearance and play. Many if not most preschool girls show some manifestation of extreme "girliness," refusing to wear anything but a dress, often pink and frilly, whereas boys are draped with superman capes or are holding swords and acting as superheroes (Dunn & Hughes 2001, Halim et al. 2009, Maccoby 1998, Ruble et al. 2007a). We know almost nothing about the stability of such behaviors after preschool, however. It may be necessary to examine how one kind of gender typing at one age relates to a different kind at a later age (McHale et al. 2004). Does a lack of interest in dresses predict later interest in sports or playing with boys? Future research using both longitudinal and retrospective methods may provide answers to such questions.

Second, it is not clear which forms of gender typing may be most stable and best characterize the essence of individual differences. The review of longitudinal studies focused on two frequently examined elements of gender typing (sex segregation and interests/activity preferences). Other aspects of gender development may turn out to be more fundamental, however, at least at some ages. One such candidate is a sense of oneself in relation to males and females. How important or central is gender to self-concept? How typical does one feel as a male or female? Multi-dimensional theories of social identity demonstrate the significance of such distinctions after the early elementary school years (Ashmore et al. 2004, Egan & Perry 2001). Moreover, perhaps stable individual differences are characterized not only by general feelings of typicality and centrality but also by the specific nature of one's fit with gender (Tobin et al. 2009). For example, one preadolescent girl may recognize that she is not a typical female in the sense of having more interest than other females have in sports and less interest in room decoration or make-up, but she may feel part of girls

as a group and want to look and act feminine in manner. Other children's sense of gender may emphasize avoiding gender-typical characteristics that they dislike: a girl may eschew the giggly, girly stuff; a boy may try to distance himself from macho elements of maleness.

Finally, future research might examine whether stable individual differences in certain gender-related cognitions emerge after preschool. Most children pass through a phase of believing that it is morally wrong for a boy to wear nail polish or for a girl to play football, but this typically ends by early elementary school (Ruble et al. 2006). Thus, individual differences in tolerance of gender-atypical behaviors may be found later. Indeed, recent research has shown quite high levels of stability (0.5–0.6) in gender role attitudes over a two-year period in 10- to 12-year-olds (McHale et al. 2004). Also, a recent study provided direct support for the idea that once the period of rigidity has passed, individual differences may emerge. Stable individual differences in reactions to gender role violations were found across two time points and related to self-esteem only for children 5 years or older, past peak rigidity (Lurye et al. 2008).

In short, our analysis of longitudinal research suggests that conclusions about the lack of evidence for stable individual differences in gender typing may have been limited by looking too hard and with too few data points for some unified construct. Although gender typing is clearly multi-dimensional, there may be stable elements in some components (e.g., behavior/interests) but not in others (e.g., attitudes/stereotypes), at least at particular ages. Perhaps, then, it would be productive to examine individual differences in gender typing as a developmentally malleable construct. Developmental factors may limit the extent to which biological predispositions can be expressed, change the way children are cognitively capable of thinking about gender, and expose them to varying social influences. Thus, the form of gender typing that is paramount may vary at different phases of life, and different combinations of biological, cognitive, and

socialization processes could contribute to individual differences in gender typing at different times.

HOW DOES THE STUDY OF GENDER DEVELOPMENT BENEFIT FROM DYNAMIC ANALYSES?

Gender development research has been guided by theories that offer differing explanations about the origins of gender typing and sex differences. These theories emphasize a variety of different processes, including cognitive developmental changes (e.g., Bigler & Liben 2007, Kohlberg 1966, Martin & Halverson 1981), socialization (Bussey & Bandura 1999, Mischel 1966), and proximal (McCarthy & Arnold 2008) and distal biological influences (e.g., evolutionary pressures) (see Ruble et al. 2006 for a review of these theories as well as the multiple distinctions currently being made for each type of process). Despite differences, a common element among these theories is reliance on data collected at one or few time points, and in rare cases, multiple assessments are made over time and then are aggregated. Aggregation and limited assessment methods provide information about concurrent relations and long-term patterns; however, these methods sacrifice important information about variability over time, and are not focused on assessing short-term, moment-to-moment changes.

By applying methods and concepts used in the physical and biological sciences, the variation that most psychologists have considered error or background noise may be found to contain “the dynamic signature of purposive behavior” (Van Orden et al. 2003, p. 331). Dynamic studies of this background noise in behavior are beginning to reveal new and potentially important insights about a range of psychological and social processes, including motor development (e.g., Adolph et al. 2003, Kelso 1995), emotional development (Lewis & Granic 2000), dyadic play (Steenbeek & van Geert 2008), structure of the self (Nowak et al. 2000), cognitive development (van Geert 2003), and stereotyping (e.g.,

Correll 2008). This revolutionary approach to describing and understanding patterns, based on complexity theory (Waldrop 1992) or commonly labeled “dynamic systems approach” or “dynamic systems theory” (Thelen & Smith 1998), has been gaining ground across fields.

Dynamic systems (DS) approaches have potential for illuminating processes involved in gender development by providing both conceptual and methodological advances that enable researchers to assess fine-grained as well as larger-grained developmental temporal variations (Lichtwarck-Aschoff et al. 2008) and, especially important for developmental research, to delineate relationships between different timescales (e.g., Lewis 2002). A comprehensive theory of gender development needs to describe and explain long-term developmental changes but must also describe how gender is experienced and plays out in short-term interactions with objects and people. DS approaches provide conceptual underpinnings and methods for identifying patterns of behavior change over time, and in some cases, how these patterns may relate to one another.

The DS approach is appealing for a number of other reasons. Gender-related topics (e.g., work and family issues) have taken center stage in heated discussions about the roles of nature versus nurture, mainly concerning the origins and nature of sex differences. Because the DS approach advocates no distinctions between the sources of influence on a system (Oyama 2000), it offers a rapprochement for debates about nature versus nurture. Furthermore, the DS approach has potential to provide a theoretical umbrella that would incorporate aspects of many gender development theories. Specifically, adopting a DS approach suggests new ways to collect, analyze, and describe data but provides limited guidance on which parameters to study; existing theories help to fill that gap.

Thus far, DS analysis of gender development has been limited to a few topics: sexual orientation (e.g., Diamond 2007), children’s sex segregation (Martin 2008, Martin et al. 2005), and mother-infant interactions (Fausto-Sterling

et al. 2008). Below, we provide a description of basic concepts of DS approaches and then employ topics in gender development and review empirical studies to illustrate some of the major features of dynamic approaches (see Thelen & Smith 1994, 1998, 2006).

Dynamics and Complex Systems: Basic Concepts

Dynamic analyses are applied to complex systems, which are systems characterized by simple, interrelated interacting elements, where the interactions of these elements give rise to higher-order global patterns (e.g., Waldrop 1992). This process, called self-organization, does not require a higher-order agent and is not preprogrammed. Structures arise as the elements spontaneously organize and reorganize into emergent systems that are larger and more complex (e.g., Williams 1997). Examples of complex systems abound: heart-rate variability, army ant swarms, termite nest building, and the formation of hurricanes.

Scientists interested in applying dynamic systems must first identify and define the variable that represents the system of interest, called the collective variable (Thelen & Smith 2006). The collective variable should be clearly defined and observable, and understanding how it behaves over different conditions is important. In developmental psychology, some classic examples of collective variables that have been studied include walking, reaching, and word learning.

Dynamic systems are marked by fluctuations from factors internal and external to the system, and this inherent activity provides potential for changes to occur in the system. In some cases, the system dampens down the fluctuations, allowing stability; in other cases, the system is “perturbed,” that is, it loses coherence, exhibits high degrees of variability, and may experience a qualitative change (i.e., phase shift) to a new coordinated state. As dynamic systems experience fluctuations, they have certain preferred states that occur with a high probability under certain conditions (called attractors). When

displaced from these preferred states, the system tends to return there (Thelen & Smith 2006). Some of these attractors are strong; others are weaker and have less “pull” on behavior. Other states act as repellers because behavior never or seldom settles there.

A goal for researchers is to understand and map both the immediate and longer-term stability/variability of complex systems. Researchers strive to identify the shifts among states because this is when the agents of change are most easily identified. These change agents (called control parameters) may be obvious (e.g., practice facilitating learning), but they also may appear incidental or minor (Thelen & Smith 2006). For instance, in a classic study, King & West (1988) found that male cowbird song development was influenced by a seemingly unimportant factor—the patterning of brief wing flickering in female cowbirds. In developmental research, an aspect of language development that may appear unrelated to another domain of language development has been identified as an agent of change: Children who show a fast rate of word learning are limited in their ability to access well-known words (Gershkoff-Stowe & Smith 1997). Regardless of their salience, such agents of change are more easily identified at transition points because they vary with changes in the collective variable.

Children’s Play Choices: Sex Segregation as a Dynamic System

Children’s tendency to assort by sex is an example of a complex system. Sex segregation is a pervasive, early-developing pattern that increases over childhood until interactions are so segregated that boys and girls have been described as growing up in separate cultures (Maccoby & Jacklin 1987). A DS analysis of sex segregation may focus on the patterns that emerge over time in a child’s choice of play partners and examine how these choices vary over the school year. Important variables to examine when children first begin congregating with peers (e.g., in a new class) might include

social factors (e.g., each child’s prior experiences with peers) as well as biological factors (e.g., hormone levels) or biosocial influences, such as the child’s temperament (e.g., being inhibited). Children’s choices are interdependent with others in the class: Choices are constrained by who is available to play on a given day, at a given time, and depend upon the choices made by others in the class immediately before the child decides to find a partner. Degrees of freedom for choosing a partner are lost the more other children have already claimed a partner.

Through repeated interactions and reshuffling, patterns of play may change as interactions become increasingly governed by children’s experiences with classmates; their responsiveness to bids, play styles, and shared interests. Individual children may settle into particular patterns of play with particular partners. For instance, from individual children’s experiences, more and longer-playing same-sex dyads may emerge in the system. As these processes play out over longer time intervals, a child’s dyadic play may grow into larger groups of same-sex children, and these groupings may be formed and maintained depending upon the interests of children or the desires or openness of the initial dyad to including other children. Interestingly, simulations have demonstrated that even when individuals show only very slight preferences for similar others, segregation emerges (Schelling 1971, Wilensky 1997).

Play patterns can also be viewed from the perspective of the entire class. A series of bird’s-eye snapshots of a playground would show that the number of children in class who are involved in sex-segregated play varies as pairings and groupings of children form and break up, with groupings shifting over time. With more children involved in same-sex groupings, these groups may have enhanced appeal, and so other children will be drawn into the groups, thus illustrating how the higher-order structure of same-sex groups may also influence patterning of interactions. Sex segregation as an emergent structure of the system may become increasingly evident at both the individual-child and

classroom levels. Although no one person directed the class or an individual child to choose same-sex partners for play, sex segregation can emerge, suggesting a self-organizing system.

Variability in Systems: Gender-Typed Activities, Sex Segregation, and Gender Identity

Dynamic systems analyses involve studying temporal patterning—how a system transforms from one state to another over time. Scientists studying a system need to understand the short- and long-term stability and change in the system so the regular variability is distinguishable from extreme variability. Extreme variability holds particular fascination as it may signal a shift of a system from one kind of attractor to a new kind of attractor, or to a more highly organized state. For this reason, scientists using dynamic analyses may use cross-sectional data to narrow their focus to the time frames of most interest and then collect intensive data about variations in the primary variables of interest as well as about potential agents of change.

A gender application to illustrate this point would be the theoretically important issue of how gender-typed toy choices emerge. Since cross-sectional research suggests that boys begin to show gender-typed toy choices (e.g., playing with trucks) around the age of two (Berenbaum et al. 2008, Ruble et al. 2006), bracketing this time with intensive data collection about toy choices would be particularly interesting. Also, to better understand factors influencing such choices, other information about the play situation (e.g., other available toys, presence of peers), parents (e.g., stereotypic beliefs), and children (e.g., gender knowledge, activity level) should be collected. Developmental changes in any of these may influence boys' sense of control or feelings of pressure concerning toy selection. Studies of fine-grained changes from day-to-day or moment-to-moment gain import, and multiple data points are needed to detect these patterns.

When children enter preschool, qualitative changes may occur in their toy and activity choices. Preschool is a dramatically different setting from that at home; more peers of both sexes are available as play partners, and adult supervision may be low. Dynamic analyses involving longitudinal data about toy choices at home and school would shed light on this transition. Analysis of the activities children engage in at home versus at preschool, and the presence and reactions of peers, would provide insights into whether children's preferences change dynamically in preschool, where many toys are available, peers may tease them for "gender-inappropriate" play, and adults may react differently than their parents.

Fine-grained data have been collected on young children's peer choices, making this topic suitable for illustrating both stability and variability in dynamic systems. Controversy has arisen about the stability of sex segregation (see How Stable Are Individual Differences in Gender Typing section, above), but it appears that as more snapshots of behavior are aggregated, sex segregation becomes more stable until it reaches a moderately high level (Martin & Fabes 2001). The stability of sex segregation may be questioned in part because of the variability in this behavior from day-to-day. To illustrate this more clearly, notice the day-to-day variation in children's play partners, based on observations conducted during the fall term for four children depicted in **Figure 1**. Variability is apparent, although two children also show strong same-sex preferences day-to-day, but the other two children do not. There also is stability over time; children's patterns remain similar into the spring term of data collection. Extending this type of analysis to explore when and how variations occur would be fascinating.

Another approach for applying dynamic analysis is to focus on the potential instability of constructs believed to be stable. Walking is a stable feature of most humans' behavior, but the exact form of walking at any given time depends on many different factors, including the type of surface being walked upon (e.g., thick

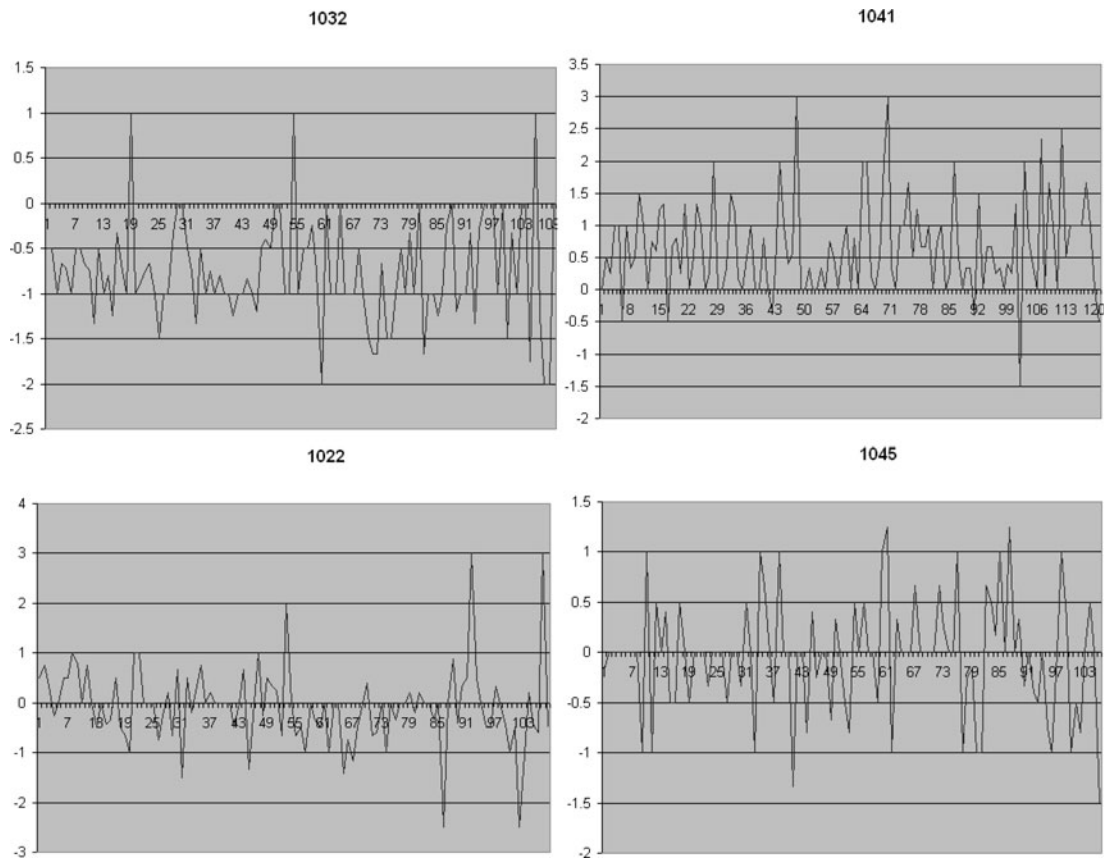


Figure 1

Day-to-day variations in children's play partner choices as a function of sex of child and long-term patterning. Observed play partner choices were summed and averaged per day of observation using the following: Each boy play partner was given a +1; each girl was given a -1. Children with ID numbers 1032 and 1022 were girls; children with ID numbers 1041 and 1045 were boys. For girls, data below the 0 point represent same-sex peer play; for boys, data above the 0 point represent same-sex play. The graphs at the top (1032 and 1041) represent patterns of children who tend to show long-term preferences for same-sex play; the graphs at the bottom represent patterns of children who tend to show long-term preferences for playing with both sexes. Variability is apparent in all the graphs (DiDonato & Martin 2009).

rug versus tiled floor, slope of surface). Most researchers think of gender identity as being a stable feature, but if we consider when variations in gender identity might occur, it broadens the perspective on gender identity. An interesting analysis would be to explore variations in feelings (e.g., gender typicality, comfort) and displays of gender identity (e.g., style of dressing, voice, gestures) over different types of social "surfaces" (e.g., being in a sports bar, holding a baby) (Martin 2000). Analysis of moment-to-moment changes in the patterning

of gender identity may reveal surprising insights about gender development (a similar point is made about identity formation in Lichtwarck-Aschoff et al. 2008). For instance, collecting intensive time-series data about feelings of gender typicality (e.g., "How similar do you feel to your own sex right now?") over a range of situations may illustrate that feelings of gender typicality are strong and show little variability in situations where one is a minority member, but that gender typicality is low but more variable when one is in a same-sex situation.

Dynamic Contexts: Gender Cognitions and Socialization

An important feature of dynamic analysis is how “context” is viewed. Although context is considered important in gender theories, it is often conceptualized as being distal (i.e., cultural contexts). In contrast, DS theorists view context as a dynamic characteristic of interactions, one that is temporally and spatially close and is an aspect of the interaction process itself (Steenbeek & van Geert 2008). Even influences typically considered distal, stable, or abstract are represented and carried forward in time by their embodiment within everyday interactions. For instance, gender stereotypes and gender identity become embodied as children dynamically engage in “gendering”—remembering gender and acting on gender—incorporating the immediate contextual factors, and this being carried forward to the next moment of knowing and acting on gender.

Developmental processes that occur in real time then carry over and become consolidated and generalized across different contexts (Fischer & Bidell 1998), and these then influence and constrain behavior (e.g., Lewis 2000) (although there is controversy about the extent to which this happens) (for review of the issue, see Witherington 2007). For instance, as toddlers come to understand their sex, become motivated by same-sex expectations, and begin to develop stereotypes, these features can be carried into interactions with others. The patterning and display of the gendered self may evolve into new forms (e.g., styles of dress, play partners, activities), which vary from moment-to-moment and over longer time periods. Thinking of gender as being enacted in each interaction is similar to proposals from sociological research traditions focusing on the social construction of gender (West & Zimmerman 1991).

Gender socialization provides a good example of how both the child’s and parents’ cognitions are enacted in moment-to-moment interactions through the dynamic embodiment of gender. Parental expectations about what it means to have a child who is either a boy or

girl (expectations colored by cultural values, etc.) become displayed as actions with the child (e.g., glances, touching, toy offering), and these embodied expectations interact with the child’s phenotypic and early behavioral features. Thus, gender socialization involves parents and siblings, peers, other socialization agents, and the individual child, who all act and interact in varied contexts.

Methods and Analyses of Dynamic Systems

Studying complex systems involves identifying the collective variables that capture the behavior of interest and then collecting a long time series of data to watch the emergence of behaviors. Social scientists may avoid dynamic analyses because they expect that they will have to collect thousands of observations to identify complex patterns of behavior. However, even shorter time frames and smaller sets of time-series data may reveal important features that traditional methods may not disclose (Williams 1997), especially when investigators use some of the newly proposed analytic techniques (e.g., Finan et al. 2008).

The recognition and study of complex systems have promoted development of an array of techniques designed to understand these systems, including techniques for nonlinear dynamics, time-series analyses, data visualization (e.g., Lamey et al. 2004), and computer simulations to model the behavior of systems (e.g., Griffin et al. 2004, Schafer et al. 2009). This new and expanded toolbox provides better ways of describing, analyzing, and interpreting temporal data of all types (Ward 2002). The mathematics involved in describing systems can be complex and unfamiliar to psychologists (e.g., May 1976); thus, DS ideas often are applied heuristically for thinking about patterns and for directing the kinds of data that are obtained rather than using the toolkit of analyses that describe obtained time-series data. However, psychologists have become increasingly interested in developing and applying these analytic tools (see Boker & Wenger 2007, van Geert 2003).

For instance, Thelen and colleagues (2001) conducted rigorous modeling of a developmental phenomenon involving touching patterns of infants (the A-not-B effect), which was originally identified by Piaget. Others are refining and expanding upon DS approaches to better integrate these ideas with connectionist models (e.g., Spencer & Schoner 2003) and neurobiology (Lewis 2005). Regardless of how it is employed, DS perspectives hold promise for revealing patterns of gender development previously unrecognized.

Dynamic Analyses of Gendered Play Partners and Activities

Not all the applications of DS to gender development are as abstract as we have presented above. In this section, we outline specific examples of studies that have been conducted to apply a dynamic systems approach to gender development.

Data visualization, attractors, and repellers in children's sex segregation. In a dynamic view of sex segregation, children are seen to settle into certain behavioral patterns. This illustrates a characteristic of a dynamic system: Despite a large number of possible patterns among system elements, only a few ever stabilize. Dynamic analyses have been used to study the patterns of children's play partners in preschool classes and the role of gender in these interactions. Martin and colleagues (2005) used a new data-visualization tool, called state space grids (SSGs), to explore the extent to which preschool children showed attraction for same-sex and behaviorally similar children. Developmental scientists interested in applying DS methods (e.g., Granic & Lamey 2002, Hollenstein et al. 2004) recognized the need for a methodology to visualize system dynamics; thus, they developed the SSG technique (e.g., Lewis et al. 1999).

SSGs involve mapping of dimensions onto a state space to determine the regularity or stability of the patterns (for a description of how to use GridWare, see Hollenstein 2007).

In Martin et al. (2005), SSGs were constructed based on children's choices of play partners derived from scan observations of three classes of preschool children over several months in order to examine whether sex of peers and behavioral tendencies act as attractors. Children were divided into types using cluster analysis: externalizing, internalizing, and socially competent children; play patterns of target children with types of peers (rather than one other child) were analyzed using SSGs. If children's play partner choices related strongly to behavioral similarity, then competent children should choose other competent children regardless of sex; if their selections relate to sex, then children should choose on the basis of similar sex regardless of behavior.

Attractors were characterized in three ways. First, a high number of individual interactions in the state space regions representing play with same-sex peers or particular peer qualities (e.g., externalizing) would indicate that those spaces are attractors. If same-sex peers act as attractors, then we would expect, for instance, that girls would have more interactions in the "girl peer" region than in the "boy peer" region. Second, when a region is an attractor, children should enter it quickly; for instance, early in the time series, girls would be expected to play with girls and would have few (or no) interactions with boys before they move into the "girl peer" region. Third, if a region is an attractor, children should return to the region quickly. Whenever girls leave the "girl peer" region, they would be expected to have relatively few interactions with boys before moving back to playing with girls.

The results supported these ideas. Same-sex peers were strong attractors for children: Both sexes had more than twice as many interactions with same-sex than with other-sex peers, were faster to return to same-sex peers, and started playing with them more quickly. Interestingly, these patterns were apparent even in the first 20 observations obtained on children after only several weeks of preschool. **Figure 2** illustrates a typical pattern for a girl's first 20 interactions. The SSG shows data from

a competent girl, whose first coded play bout is with a girl (open circle), and the pattern shows that she plays with girls more than with boys. Externalizing and social competence also contributed to behavioral states, but patterns varied by sex of child and peer (e.g., boys were more attracted to externalizing boys than to externalizing girls). As **Figure 2** illustrates, the competent girl played much more with competent girls than with other girls, but she did not play with competent boys at all. Overall, the findings suggest that both the sex of peers and their behavioral qualities help fashion the social organization in the classroom.

In a similar study, Martin (2008) compared patterns of children who were highly gender typed in play to those with less gender-typed play patterns in order to examine whether children who differed in their overall patterns showed differences early in the time series of observations. Interestingly, within the first 20 observed interactions, highly gender-typed children experienced more positive emotions with same-sex than with other-sex peers; less gender-typed children showed no difference. These findings suggest that children who have early positive emotional experiences with same-sex peers but not with other-sex peers incorporate these experiences into their play, such that same-sex peers have increasing appeal, whereas other-sex peers lose their appeal. In this way, emotional experiences with peers appear to contribute to the overall patterning of children's play and to sex segregation in the class.

These studies use data-visualization techniques to illustrate a new approach to examining peer interaction patterns and suggest that both the sex of peers and peers' behavior act as attractors. Additional research involving moment-to-moment coding of behavior and new techniques for analyzing group patterns will allow for even more detailed dynamic analyses of children's behavior with peers.

Self-organized criticality in the temporal patterning of children's gendered behavior. Many complex systems show a particularly intriguing pattern of organization, called

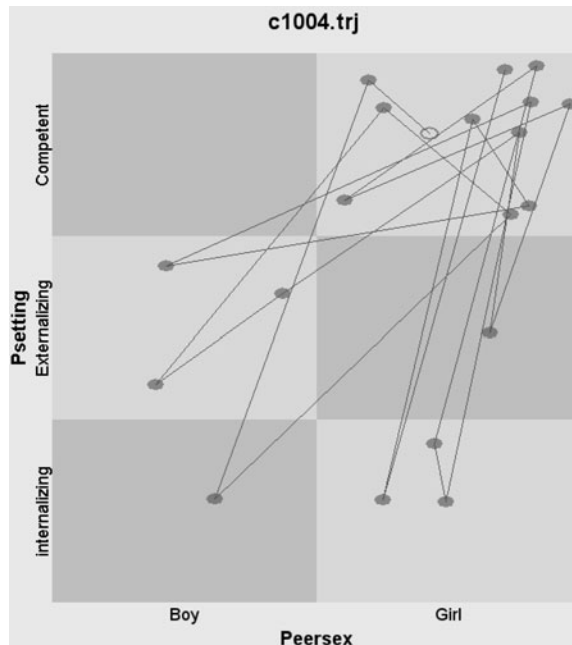


Figure 2

A socially competent girl's state space grid, illustrating her patterns of play with peers of different sexes and different behavioral qualities over the first 20 observed interactions. The *x*-axis represents the sex of the peer with whom the target girl interacts; the *y*-axis represents the behavioral quality of the peers as determined by clustering teacher ratings of children's behavior. Each solid circle represents a single observed interaction, and the open circle represents the first observed interaction (with a socially competent girl). Lines between circles represent the ordering of observations. This girl showed strong sex selection: 16 of her first 20 interactions were with girls. She also showed a preference for interacting with socially competent girls but not boys (Martin 2008).

self-organization near a critical state. These systems are balanced between enough stability to maintain order and enough instability or variation to be adaptive to change (Bak et al. 1989). Adaptability is enhanced because new alternatives can be generated as needed in response to varying circumstances (e.g., Van Orden et al. 2003). In physiological systems, self-organized criticality is associated with well-being and health, and its loss or deterioration is related to disease, depression, and aging (Goldberger 1996, Linkenkaer-Hansen et al. 2005, Sosnoff & Newell 2008).

Self-organization near a critical state involves "self-similarity" across time-scales; in other words, if one small portion of the time series is magnified, its appearance is similar to

the larger time series in which it is embedded. That is, small-scale patterns reflect the patterns that would be expected at larger scales, such that identifying a regularity in a 2-minute window of time may share similarity to a pattern found in a 16-minute window, and both may share similarity to a pattern found on a much longer timescale (e.g., developmental changes that occur from early to later childhood). This self-organization near a critical state is represented by the presence of long-term, positively correlated variability in a time series (Treffner & Kelso 1999, Van Orden et al. 2003). Time series with completely independent data do not exhibit self-similarity. Given the implications for understanding different timescales and how they relate to one another, the implications of finding self-similarity in systems are far-ranging, especially for developmental scientists.

DiDonato (2008) applied both dynamic and traditional analyses to explore whether children's gendered behavior shows self-organized criticality and whether temporal patterns relate to children's adjustment. Brief observations of preschool children's activities and play partners were conducted daily over several months. By combining gender typing of activities and play partners across observations each day, DiDonato derived a single indicator of gendered behavior. Each child's time series was plotted and analyzed for self-organized criticality (e.g., Hurst 1951), and the results indicated this pattern, suggesting that children exhibited flexibility in their gendered behavior. For example, the implication of the findings is that a girl who normally plays with girls may adapt her behavior by playing with a boy if he is playing with her favorite toy. Furthermore, flexibility in gendered behavior was positively related to adjustment in girls but not in boys. Boys' restricted gender roles may constrain the relation between flexible behavior and adjustment.

These findings have implications for debates about how gender roles relate to adjustment and provide a compelling example of how both traditional and dynamic approaches can be combined to yield more information than would either approach alone. In this case, the short-term

patterning of activities and partners related to adjustment, and it suggests that further explorations of changes in children's gendered behavior at different timescales are warranted.

In sum, DS approaches have potential for providing a new lens for viewing gender development. DS approaches adopt unique views of context, focus on describing variability, provide information about patterning of behavior over both short and longer developmental time frames, and suggest new techniques and different methods of data analyses and collection. Adopting a DS approach also has the potential to provide an all-encompassing theoretical umbrella and deflates controversy surrounding the roles of nature and nurture in gender development. At a broader level, DS approaches cross-cut disciplinary boundaries, bridging methods and concepts across disciplines. Highlights of the appeal of exploring DS approaches include discovering new answers to old problems, recognizing new types of questions, and ultimately advancing alternative accounts of gender development.

CONCLUSIONS

Children's gender development unfolds over long time frames of average or normative change, over shorter time frames such as the emergence of relatively stable individual preferences in with whom or with what to play during the early school years, and over much shorter time frames—micro timescales—such as when an individual child selects an outfit to wear or carries on an interaction with a peer over a toy. In the present review, we illustrated each of these time frames in terms of a few specific current, and sometimes controversial, topics in the field of gender development.

First, we took the long view, examining normative changes from infancy through middle adolescence in key aspects of children's beliefs and behaviors regarding gender distinctions. In this way, we were able to speak to the question of temporal ordering of different elements of gender development and, thereby, analyze certain controversies within the field

about how early children understand gender distinctions and how that understanding relates to behavior. Moreover, the analysis of temporal ordering helps generate hypotheses for future research about what indications of gender prejudice, such as ingroup favoritism, might represent for young children who can understand gender stereotypes but not necessarily status inequities between the sexes.

Normative trends involve only averages across individuals; they do not, however, inform us about whether there are stable individual differences in expressions of gender typing. Whether there are continuities in individual gender typing over time has been another important but controversial topic in gender development. For instance, identifying stability in sex segregation would suggest that individual children vary in their preferences and that sex segregation is not simply due to situational variability or normative constraints as had previously been assumed. Thus, in the second section, we reviewed studies of longitudinal change within individuals over shorter periods of time. We discovered that there is more stability in sex segregation and gender-typed activities and preferences than previously thought. However, future research must determine how long stability exists and over which periods of development.

Another advantage of normative trends is that they indicate at what points developmentally it would be useful to search for stable individual differences, such as after periods of rapid

change, as when children first enter preschool. In the third section, we described a new tool for taking advantage of such opportunities. Dynamic systems theory provides a coherent set of principles and methods for examining change over differing time frames. Socialization, cognitive, and biological processes can be explored over multiple time frames using techniques that focus on temporal patterning of behavior. Dynamic systems theory complements existing theories by providing more nuanced views of gender at different timescales. For instance, sex segregation exhibits both variability and stability from a dynamic perspective. Particularly intriguing is the potential for small-scale patterns to provide insights into large-scale patterns. For systems that exhibit self-similarity, a pattern that appears at a microlevel time frame mimics the pattern found at a more macrolevel time frame. Considering similarity across timescales is an idea that, in our view, has no counterpart in developmental research or theorizing.

Developmental research on gender has primarily focused attention on the longer timescales to assess normative developmental patterning. Less attention has been focused on shorter timescales to explore individual patterns and stability of behavior, and very little has been done to explore gender development in terms of micro timescales. We hope our review has made it clear that comprehensive explanations of gender need to consider each of these timescale perspectives.

DISCLOSURE STATEMENT

The authors are not aware of any biases that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

This review was supported by a grant from the National Institute of Child Health and Human Development (1 R01 HD45816) and a grant from the T. Denny Sanford Foundation awarded to Carol Lynn Martin; a National Institute of Child Health and Human Development Research Grant (1 R01 HD04994) to Diane N. Ruble; and a National Science Foundation IRADS grant (0721383). We are very grateful to Faith Greulich for assistance in preparing the manuscript and to Nia Amazeen, Matt DiDonato, May Ling Halim, Tom Hollenstein, and Kristina Zosuls for comments on an earlier draft.

LITERATURE CITED

- Adolph KE, Vereijken B, Shrout PE. 2003. What changes in infant walking and why. *Child Dev.* 74:475–97
- Alexander GM, Hines M. 1994. Gender labels and play styles: their relative contribution to children's selection of playmates. *Child Dev.* 65:869–79
- Arthur AE, Bigler RS, Liben LS, Gelman SA, Ruble DN. 2008. Gender stereotyping and prejudice: a developmental intergroup perspective. In *Intergroup Attitudes and Relations in Childhood Through Adulthood*, ed. S Levy, M Killen, pp. 66–85. New York: Oxford Univ. Press
- Ashmore RD, Deaux K, McLaughlin-Volpe T. 2004. An organizing framework for collective identity: articulation and significance of multidimensionality. *Psychol. Bull.* 130:80–114
- Bak P, Chen K, Creutz M. 1989. Self-organized criticality in the “Game of Life.” *Nature* 342:780–81
- Baldwin DA, Moses LK. 1996. The ontogeny of social information gathering. *Child Dev.* 67:1915–39
- Bandura A, Bussey K. 2004. On broadening the cognitive, motivational, and sociocultural scope of theorizing about gender development and functioning: comment on Martin, Ruble, and Szkrybalo (2002). *Psychol. Bull.* 130:691–701
- Bartini M. 2006. Gender role flexibility in early adolescence: developmental change in attitudes, self-perceptions, and behaviors. *Sex Roles* 55:233–45
- Bauer PJ, Liebl M, Stennes L. 1998. Pretty is to dress as brave is to suitcoat: gender-based property-to-property inferences by 4-1/2-year-old children. *Merrill-Palmer Q.* 44:355–77
- Berenbaum SA, Martin CL, Hanish LD, Briggs PT, Fabes RA. 2008. Sex differences in children's play. In *Sex Differences in the Brain: From Genes to Behavior*, ed. JB Becker, KJ Berkley, N Geary, E Hampson, JP Herman, EA Young, pp. 275–90. Oxford, UK: Oxford Univ. Press
- Berndt TJ, Heller KA. 1986. Gender stereotypes and social inferences: a developmental study. *J. Personal. Soc. Psychol.* 50:889–98
- Bigler RS, Arthur AE, Hughes JM. 2008. The politics of race and gender: children's perceptions of discrimination and the U.S. presidency. *Anal. Soc. Issues Public Policy* 8:1–30
- Bigler RS, Jones LC, Lobliner DB. 1997. Social categorization and the formation of intergroup attitudes in children. *Child Dev.* 68:530–43
- Bigler RS, Liben LS. 2007. Developmental intergroup theory: explaining and reducing children's social stereotyping and prejudice. *Curr. Dir. Psychol. Sci.* 16:162–66
- Boker SM, Wenger MJ. 2007. *Data Analytic Techniques for Dynamical Systems*. Mahwah, NJ: Erlbaum
- Brewer MB. 2001. Ingroup identification and intergroup conflict: When does ingroup love become outgroup hate? In *Social Identity, Intergroup Conflict, and Conflict Reduction*, ed. RD Ashmore, L Jussim, D Wilder, pp. 17–41. New York: Oxford Univ. Press
- Brown CS, Bigler RS. 2005. Children's perceptions of discrimination: a developmental model. *Child Dev.* 76:533–53
- Bussey K, Bandura A. 1999. Social cognitive theory of gender development and differentiation. *Psychol. Rev.* 106:676–713
- Cameron JA, Alvarez JM, Ruble DN, Fuligni AJ. 2001. Children's lay theories about ingroups and outgroups: reconceptualizing research on “prejudice.” *Personal. Soc. Psychol. Rev.* 5:118–28
- Campbell A, Shirley L, Caygill L. 2002. Sex-typed preferences in three domains: Do two-year-olds need cognitive variables? *Br. J. Psychol.* 93:203–17
- Connor JM, Serbin LA. 1977. Behaviorally-based masculine and feminine activity preference scales for preschoolers: correlates with other classroom behaviors and cognitive tests. *Child Dev.* 48:1411–16
- Correll J. 2008. *1/f* noise and effort on implicit measures of bias. *J. Personal. Soc. Psychol.* 94:48–59
- Deaux K, Lewis LL. 1984. Structure of gender stereotypes: inter-relationships among components and gender label. *J. Personal. Soc. Psychol.* 46:991–1004
- Diamond L. 2007. A dynamic systems approach to the development and expression of female same-sex sexuality. *Perspect. Psychol. Sci.* 2:142–61
- DiDonato MD. 2008. *Children's gendered behavior and psychological adjustment: longitudinal and dynamic relations*. Thesis, Arizona State Univ., Tempe
- DiDonato MD, Martin CL. 2009. Variations in children's play patterns day to day. Tempe, AZ. Manuscript in preparation.

- Dunn J, Hughes C. 2001. "I got some swords and you're dead!": violent fantasy, antisocial behavior, friendship, and moral sensibility in young children. *Child Dev.* 72:491-505
- Edelbrock C, Sugawara AI. 1978. Acquisition of sex-typed preferences in preschool children. *Dev. Psychol.* 14:614-23
- Egan SK, Perry DG. 2001. Gender identity: a multidimensional analysis with implications for psychosocial adjustment. *Dev. Psychol.* 37:451-63
- Epstein S. 1980. The stability of behavior: II. Implications for psychological research. *Am. Psychol.* 35:790-806
- Fagan JF, Singer LT. 1979. The role of simple feature differences in infants' recognition of faces. *Infant Behav. Dev.* 2:39-45
- Fausto-Sterling A, Coll CG, Schooler D. 2008. *Towards a dynamic study of gender in infant development*. Presented at Gender Dev. Conf., San Francisco
- Finan PH, Hessler EE, Amazeen PG, Butner J, Zautra AJ, Tennen H. 2009. Nonlinear oscillations in pain prediction accuracy. *Nonlinear Dynamics Psychol. Life Sci.* In press
- Fischer KW, Bidell TR. 1998. Dynamic development of psychological structures in action and thought. In *Handbook of Child Psychology: Vol. 1. Theoretical Models of Human Development*, ed. RM Lerner, pp. 313-99. New York: Wiley
- Gershkoff-Stowe L, Smith LB. 1997. A curvilinear trend in naming errors as a function of early vocabulary growth. *Cogn. Psychol.* 34:37-71
- Giles JW, Heyman GD. 2005. Young children's beliefs about the relationship between gender and aggressive behavior. *Child Dev.* 76:107-21
- Glick P, Fiske ST. 2001. Ambivalent sexism. In *Advances in Experimental Social Psychology*, ed. MP Zanna, pp. 115-88. Thousand Oaks, CA: Academic
- Goldberger AL. 1996. Non-linear dynamics for clinicians: chaos theory, fractals, and complexity at the bedside. *Lancet* 347:1312-14
- Golombok S, Rust J. 1993. The Pre-school Activities Inventory: a standardized assessment of gender role in children. *Psychol. Assess.* 5:131-36
- Golombok S, Rust J, Zervoulis K, Croudace T, Golding J, Hines M. 2008. Developmental trajectories of sex-typed behavior in boys and girls: a longitudinal general population study of children aged 2.5-8 years. *Child Dev.* 79:1583-93
- Granic I, Lamey AV. 2002. Combining dynamic-systems and multivariate analyses to compare the mother-child interactions of externalizing subtypes. *J. Abnorm. Child Psychol.* 30:265-83
- Griffin WA, Hanish LD, Martin CL, Fabes RA, Barcelo H, Greenwood P. 2004. PlayMate: new data, new rules, and model validity. In *Agent 2004: Social Dynamics: Interaction, Reflexivity and Emergence*, ed. DL Sallach, CM Macal, MJ North, pp. 339-51. Univ. Chicago & Argonne Natl. Lab.
- Halim ML, Ruble DN. 2009. Gender identity and stereotyping in early and middle childhood. In *Handbook of Gender Research in Psychology*, ed. JC Chrisler, DR McCreary. New York: Springer-Verlag. In press
- Halim ML, Ruble DN, Greulich F, Lurye LE, Zosuls KM. 2009. Pink frilly dresses: early obsessions and social identity. Manuscript submitted
- Heyman GD. 2001. Children's interpretation of ambiguous behavior: evidence for a "boys are bad" bias. *Soc. Dev.* 10:230-47
- Hollenstein T. 2007. State space grids: analyzing dynamics across development. *Int. J. Behav. Dev.* 31:384-96
- Hollenstein T, Granic I, Stoolmiller M, Snyder J. 2004. Rigidity in parent-child interactions and the development of externalizing and internalizing behavior in early childhood. *J. Abnorm. Child Psychol.* 32:598-602
- Hurst HE. 1951. Long term storage capacity of reservoirs. *Trans. Am. Soc. Civil Eng.* 116:770-99
- Huston AC. 1983. Sex typing. In *Handbook of Child Psychology: Socialization, Personality, and Social Development*, ed. EM Hetherington, pp. 387-467. New York: Wiley
- Kelso JAS. 1995. *Dynamic Patterns: The Self Organization of Brain and Behavior*. Cambridge, MA: MIT Press
- Killen M, McGlothlin H, Henning A. 2008. Implicit biases and explicit judgments: a developmental perspective. In *Intergroup Attitudes and Relations in Childhood Through Adulthood*, ed. SR Levy, M Killen, pp. 126-45. Oxford, UK: Oxford Univ. Press
- Killen M, Stangor C. 2001. Children's social reasoning about inclusion and exclusion in gender and race peer group contexts. *Child Dev.* 72:174-86

GridWare (Version 1.1).
Freeware available at
<http://www.oise.utoronto.ca/ssg/gridware.php>

- King A, West M. 1988. Searching for the functional origins of cowbird song in eastern brown-headed cowbirds (*Molothrus ater*). *Anim. Behav.* 36:1575–88
- Kohlberg LA. 1966. A cognitive-developmental analysis of children's sex role concepts and attitudes. In *The Development of Sex Differences*, ed. EE Maccoby, pp. 82–173. Stanford, CA: Stanford Univ. Press
- Kowalski K. 2007. The development of social identity and intergroup attitudes in young children. In *Contemporary Perspectives on Social Learning in Early Childhood Education*, ed. ON Saracho, B Spodek, pp. 51–84. Charlotte, NC: Inform. Age Publ.
- Kuhn D, Nash SC, Brucken L. 1978. Sex role concepts of two- and three-year-olds. *Child Dev.* 49:445–51
- La Freniere P, Strayer FF, Gauthier R. 1984. The emergence of same-sex affiliative preferences among preschool peers: a developmental/ethological perspective. *Child Dev.* 55:1958–65
- Lamey AV, Hollenstein T, Lewis MD, Granic I. 2004. GridWare (version 1.1B). <http://statespacegrids.org>
- Langlois JH, Downs AC. 1980. Mothers, fathers, and peers as socialization agents of sex-typed play behaviors in young children. *Child Dev.* 51:1237–47
- Leinbach MD, Hort BE, Fagot BI. 1997. Bears are for boys: metaphorical associations in young children's gender stereotypes. *Cogn. Dev.* 12:107–30
- Levy GD. 1999. Gender-typed and non-gender-typed category awareness in toddlers. *Sex Roles* 41:851–73
- Levy GD, Haaf RA. 1994. Detection of gender-related categories by 10-month-old infants. *Infant Behav. Dev.* 17:457–59
- Lewis MD. 2000. The promise of dynamic systems approaches for an integrated account of human development. *Child Dev.* 71:36–43
- Lewis MD. 2002. Interacting time scales in personality (and cognitive) development: intentions, emotions, and emergent forms. In *Microdevelopment: Transition Processes in Development and Learning*, ed. N Granott, J Parziale, pp. 183–212. New York: Cambridge Univ. Press
- Lewis MD. 2005. Bridging emotion theory and neurobiology through dynamic systems modeling. *Behav. Brain Sci.* 28:105–30
- Lewis MD, Granic I. 2000. *Emotion, Development, and Self-Organization: Dynamic Systems Approaches to Emotional Development*. Cambridge, UK: Cambridge Univ. Press
- Lewis MD, Lamey AV, Douglas L. 1999. A new dynamic systems method for the analysis of early socioemotional development. *Dev. Sci.* 2:457–75
- Liben LS, Bigler RS. 2002. The developmental course of gender differentiation. In *Monographs of the Society for Research in Child Development*, ed. W Overton, pp. vii–147. Cambridge, MA: Blackwell Sci.
- Liben LS, Bigler RS, Krogh HR. 2001. Pink and blue collar jobs: children's judgments of job status and job aspirations in relation to sex of worker. *J. Exp. Child Psychol.* 79:346–63
- Lichtwarck-Aschoff A, van Geert P, Bosma H, Kunnen S. 2008. Time and identity: a framework for research and identity formation. *Dev. Rev.* 28:370–400
- Linkenkaer-Hansen K, Monto S, Rytala H, Suominen K, Isometsa E, Kahkonen S. 2005. Breakdown of long-range temporal correlations in theta oscillations in patients with major depressive disorder. *J. Neurosci.* 25:10131–37
- Lloyd B, Duveen G. 1992. *Gender Identities and Education: The Impact of Starting School*. New York: St. Martin's Press
- Lurye LE, Zosuls KM, Ruble DN. 2008. Gender identity and adjustment: understanding the impact of individual and normative differences in sex typing. *New Dir. Child Adolesc. Dev.* 120:31–46
- Lutz SE, Ruble DN. 1995. Children and gender prejudice: context, motivation, and the development of gender conceptions. In *Annals of Child Development*, ed. R Vasta, pp. 131–66. London: Jessica Kingsley Publ.
- Maccoby EE. 1998. *The Two Sexes: Growing Up Apart, Coming Together*. Cambridge, MA: Belknap
- Maccoby EE. 2002. Gender and group process: a developmental perspective. *Curr. Dir. Psychol. Sci.* 11:54–58
- Maccoby EE, Jacklin CN. 1987. Gender segregation in childhood. In *Advances in Child Development and Behavior*, Vol. 20, ed. WR Hayne, pp. 239–87. Orlando, FL: Academic
- Martin CL. 2000. Cognitive theories of gender development. In *The Developmental Social Psychology of Gender*, ed. T Eckes, HM Trautner, pp. 91–121. Mahwah, NJ: Erlbaum
- Martin CL. 2008. *Moving beyond the dyad: dynamic systems, gender, and social relationships in young children*. Presented at Gender Dev. Conf., San Francisco, CA

- Martin CL, Fabes RA. 2001. The stability and consequences of young children's same-sex peer interactions. *Dev. Psychol.* 37:431-46
- Martin CL, Fabes RA, Hanish LD, Hollenstein T. 2005. Social dynamics in the preschool. *Dev. Rev.* 25:299-327
- Martin CL, Halverson C. 1981. A schematic processing model of sex typing and stereotyping in children. *Child Dev.* 52:1119-34
- Martin CL, Ruble DN. 2004. Children's search for gender cues: cognitive perspectives on gender development. *Curr. Dir. Psychol. Sci.* 13:67-70
- Martin CL, Ruble DN, Szkrybalo J. 2002. Cognitive theories of early gender development. *Psychol. Bull.* 128:903-33
- Martin CL, Ruble DN, Szkrybalo J. 2004. Recognizing the centrality of gender identity and stereotype knowledge in gender development and moving toward theoretical integration: reply to Bandura and Bussey (2004). *Psychol. Bull.* 130:702-10
- Martin CL, Wood CH, Little JK. 1990. The development of gender stereotype components. *Child Dev.* 61:1891-904
- May RM. 1976. Simple mathematical models with very complicated dynamics. *Nature* 261:64-72
- McCarthy MM, Arnold AP. 2008. Sex differences in the brain: What's old and what's new? In *Sex Differences in the Brain: From Genes to Behavior*, ed. JB Becker, KJ Berkley, N Geary, E Hampson, JP Herman, EA Young, pp. 15-33. Oxford, UK: Oxford Univ. Press
- McGuire J, Martin CL, Fabes RA, Hanish LD. 2007. *The role of "gender enforcers" in young children's peer interactions*. Poster presented at Biennial Mtg. Soc. Res. Child Dev., Boston, MA
- McHale SM, Kim J, Whiteman S, Crouter AC. 2004. Links between sex-typed time use in middle-childhood and gender development in early adolescence. *Dev. Psychol.* 40:868-81
- Miller C, Lurye LE, Zosuls KM, Ruble DN. 2009. Accessibility of gender stereotype domains: developmental and gender differences in children. *Sex Roles* 60: 870-81
- Miller CL. 1983. Developmental changes in male/female voice classification by infants. *Infant Behav. Dev.* 6:313-30
- Mischel W. 1966. A social learning view of sex differences in behavior. In *The Development of Sex Differences*, ed. E Maccoby, pp. 57-81. Stanford, CA: Stanford Univ. Press
- Neff KD, Cooper CE, Woodruff AL. 2007. Children's and adolescents' developing perceptions of gender inequality. *Soc. Dev.* 16:682-99
- Nowak A, Vallacher RR, Tesser A, Borkowski W. 2000. Society of the self: the emergence of collective properties in self-structure. *Psychol. Rev.* 107:39-61
- Oyama S. 2000. *Evolution's Eye: A Systems View of the Biology-Culture Divide*. Durham, NC: Duke Univ. Press
- Poulin-Dubois D, Serbin LA, Derbyshire A. 1998. Toddlers' intermodal and verbal knowledge about gender. *Merrill-Palmer Q.* 44:338-54
- Powlishta KK, Serbin LA, Doyle A, White DR. 1994. Gender, ethnic, and body type biases: the generality of prejudice in childhood. *Dev. Psychol.* 30:526-36
- Powlishta KK, Serbin LA, Moller LC. 1993. The stability of individual differences in gender typing: implications for understanding gender segregation. *Sex Roles* 29:723-37
- Quinn PC, Yahr J, Kuhn A, Slater AM, Pascalis O. 2002. Representation of the gender of human faces by infants: a preference for female. *Perception* 31:1109-21
- Ruble DN, Alvarez J, Bachman M, Cameron J, Fuligni A, et al. 2004. The development of a sense of self: the development and implications of children's collective identity. In *The Development of the Social Self*, ed. M Bennett, F Sani, pp. 29-76. East Sussex, UK: Psychol. Press
- Ruble DN, Dweck CS. 1995. Self-perceptions, person conceptions, and their development. In *Social Development. Review of Personality and Social Psychology*, ed. N Eisenberg, Ch. 15, pp. 109-39. Thousand Oaks, CA: Sage
- Ruble DN, Lurye LE, Zosuls KM. 2007a. Pink frilly dresses (PFD) and early gender identity. *Princeton Report Knowledge (P-ROK)* 2:2
- Ruble DN, Martin CL, Berenbaum SA. 2006. Gender development. In *Handbook of Child Development*, ed. N Eisenberg, pp. 858-932. New York: Wiley

- Ruble DN, Taylor LJ, Cyphers L, Greulich FK, Lurye LE, Shrout PE. 2007b. The role of gender constancy in early gender development. *Child Dev.* 78:1121–36
- Rudman LA, Glick P. 2008. *The Social Psychology of Gender: How Power and Intimacy Shape Gender Relations*. New York: Guilford. 386 pp.
- Schafer DR, Light JM, Fabes RA, Hanish LD, Martin CL. 2009. Fundamental principles of network formation among preschool children. *Soc. Networks*. In press
- Schelling TC. 1971. Dynamic models of segregation. *J. Math. Sociol.* 1:143–86
- Serbin LS, Powlisha KK, Gulko J. 1993. The development of sex typing in middle childhood. In *Monographs of the Society for Research in Child Development*, ed. WC Bronson, pp. v–74. Chicago, IL: Univ. Chicago Press
- Signorella ML, Bigler RS, Liben LS. 1993. Developmental differences in children's gender schemata about others: a meta-analytic review. *Dev. Rev.* 13:147–83
- Sinno SM, Killen M. 2009. Moms at work and dads at home: children's evaluations of parental roles. *Appl. Dev. Sci.* 13:16–29
- Sosnoff JJ, Newell KM. 2008. Age-related loss of adaptability to fast time scales in motor variability. *J. Gerontol. Ser. B: Psychol. Sci. Soc. Sci.* 63:344–52
- Spencer JP, Schoner G. 2003. Bridging the representational gap in the dynamic systems approach to development. *Dev. Sci.* 6:392–412
- Stroufe LA, Bennett C, Englund M, Urban J, Shulman S. 1993. The significance of gender boundaries in preadolescence: contemporary correlates and antecedents of boundary violation and maintenance. *Child Dev.* 64:455–66
- Steenbeek H, van Geert P. 2008. An empirical validation of a dynamic systems model of interaction: Do children of different sociometric statuses differ in their dyadic play? *Dev. Sci.* 11:253–81
- Stennes LM, Burch MM, Sen MG, Bauer PJ. 2005. A longitudinal study of gendered vocabulary and communicative action in young children. *Dev. Psychol.* 41:75–88
- Susskind JE, Hodges C. 2007. Decoupling children's gender-based in-group positivity from out-group negativity. *Sex Roles* 56:707–16
- Teig S, Susskind JE. 2008. Truck driver or nurse? The impact of gender roles and occupational status on children's occupational preferences. *Sex Roles* 58:848–63
- Theimer CE, Killen M, Stangor C. 2001. Young children's evaluations of exclusion in gender-stereotypic peer contexts. *Dev. Psychol.* 37:18–27
- Thelen E, Schoner G, Scheier C, Smith LB. 2001. The dynamics of embodiment: a field theory of infant perseverative reaching. *Behav. Brain Sci.* 24:1–34
- Thelen E, Smith LA. 1994. *A Dynamic Systems Approach to the Development of Cognition and Action*. Cambridge, MA: Bradford/MIT Press
- Thelen E, Smith LB. 1998. Dynamic systems theories. In *Handbook of Child Psychology*, ed. W Damon, pp. 563–634. New York: Wiley
- Thelen E, Smith LB. 2006. Dynamic systems theories. In *Handbook of Child Psychology: Theoretical Models of Human Development*, ed. RM Lerner, pp. 258–312. New York: Wiley
- Thorne B. 1993. *Gender Play: Girls and Boys in School*. New Brunswick, NJ: Rutgers Univ. Press
- Tobin DD, Menon M, Menon M, Spatta BC, Hodges EVE, Perry DG. 2009. The intrapsychics of gender: a model of self-socialization. *Psychol. Rev.* Manuscript under review
- Trautner HM, Ruble DN, Cyphers L, Kirsten B, Behrendt R, Hartman P. 2005. Rigidity and flexibility of gender stereotypes in children: developmental or differential? *Infant Child Dev.* 14:365–80
- Treffner PJ, Kelso JAS. 1999. Dynamic encounters: long memory during functional stabilization. *Ecol. Psychol.* 11:103–37
- Turner P, Gervai J, Hinde RA. 1993. Gender-typing in young children: preferences, behaviour, and cultural differences. *Br. J. Dev. Psychol.* 11:323–42
- van Geert P. 2003. Dynamic systems approaches and modeling of developmental processes. In *Handbook of Developmental Psychology*, ed. J Valsiner, KJ Connolly, pp. 640–72. London: Sage
- Van Orden GC, Holden JG, Turvey MT. 2003. Self-organization of cognitive performance. *J. Exp. Psychol.: Gen.* 132:331–50

- Verkuyten M, Thijs J. 2001. Ethnic and gender bias among Dutch and Turkish children in late childhood: the role of social context. *Infant Child Dev.* 10:203–17
- Waldrop MM. 1992. *Complexity: The Emerging Science at the Edge of Order and Chaos*. New York: Simon & Schuster
- Ward LM. 2002. *Dynamic Cognitive Science*. Cambridge, MA: Bradford
- Weinraub M, Clemens LP, Sockloff A, Etheridge R, Gracely E, Myers B. 1984. The development of sex role stereotypes in the third year: relationships to gender labeling, gender identity, sex-typed toy preferences, and family characteristics. *Child Dev.* 55:1493–503
- West C, Zimmerman DH. 1991. Doing gender. In *The Social Construction of Gender*, ed. J Lorber, SA Farrell, pp. 13–37. Thousand Oaks, CA: Sage
- Wilensky U. 1997. NetLogo segregation model. In *Learning and Computer-Based Modeling*. Evanston, IL: Northwestern Univ. <http://ccl.northwestern.edu/netlogo/models/Segregation>. Center for Connected Learning and Computer-Based Modeling, Northwestern Univ., Evanston, IL**
- Williams GP. 1997. *Chaos Theory Tamed*. Washington, DC: Joseph Henry Press
- Witherington DC. 2007. The dynamic systems approach as a metatheory for development psychology. *Hum. Dev.* 50:127–53
- Yee M, Brown R. 1994. The development of gender differentiation in young children. *Br. J. Soc. Psychol.* 33:183–96
- Younger BA, Fearing DD. 1999. Parsing items into separate categories: developmental change in infant categorization. *Child Dev.* 70:291–303
- Zosuls KM, Ruble DN, Tamis-LeMonda CS, Shrout PE, Bornstein MH, Greulich FK. 2009. The acquisition of gender labels in infancy: implications for sex-typed play. *Dev. Psychol.* 45:688–701
- Zucker KJ, Bradley SJ. 1995. *Gender Identity Disorder and Psychosexual Problems in Children and Adolescents*. New York: Guilford
- Zucker KJ, Wilson-Smith DN, Kurita JA, Stern A. 1995. Children's appraisals of sex-typed behavior in their peers. *Sex Roles* 33:703–25

A NetLogo model that can be run with varying parameters; illustrates the emergence of segregation in a system.



Contents

Prefatory

Love in the Fourth Dimension <i>Ellen Berscheid</i>	1
--	---

Brain Mechanisms and Behavior

The Role of the Hippocampus in Prediction and Imagination <i>Randy L. Buckner</i>	27
--	----

Learning and Memory Plasticity; Neuroscience of Learning

Hippocampal-Neocortical Interactions in Memory Formation, Consolidation, and Reconsolidation <i>Szu-Han Wang and Richard G.M. Morris</i>	49
--	----

Stress and Neuroendocrinology

Stress Hormone Regulation: Biological Role and Translation Into Therapy <i>Florian Holsboer and Marcus Ising</i>	81
--	----

Developmental Psychobiology

Structural Plasticity and Hippocampal Function <i>Benedetta Leuner and Elizabeth Gould</i>	111
---	-----

Cognitive Neuroscience

A Bridge Over Troubled Water: Reconsolidation as a Link Between Cognitive and Neuroscientific Memory Research Traditions <i>Oliver Hardt, Einar Örn Einarsson, and Karim Nader</i>	141
--	-----

Cognitive Neural Prosthetics

<i>Richard A. Andersen, Eun Jung Hwang, and Grant H. Mulliken</i>	169
---	-----

Speech Perception

Speech Perception and Language Acquisition in the First Year of Life <i>Judit Gervain and Jacques Mehler</i>	191
---	-----

Chemical Senses (Taste and Smell)

An Odor Is Not Worth a Thousand Words: From Multidimensional
 Odors to Unidimensional Odor Objects
Yaara Yeshurun and Noam Sobel 219

Somesthetic and Vestibular Senses

Somesthetic Senses
Mark Hollins 243

Basic Learning and Conditioning

Learning: From Association to Cognition
David R. Shanks 273

Comparative Psychology

Evolving the Capacity to Understand Actions, Intentions, and Goals
Marc Hauser and Justin Wood 303

Human Development: Processes

Child Maltreatment and Memory
Gail S. Goodman, Jodi A. Quas, and Christin M. Ogle 325

Emotional, Social, and Personality Development

Patterns of Gender Development
Carol Lynn Martin and Diane N. Ruble 353

Adulthood and Aging

Social and Emotional Aging
Susan T. Charles and Laura L. Carstensen 383

Development in Societal Context

Human Development in Societal Context
Aletha C. Huston and Alison C. Bentley 411

Genetics and Psychopathology

Epigenetics and the Environmental Regulation
 of the Genome and Its Function
Tie-Yuan Zhang and Michael J. Meaney 439

Social Psychology of Attention, Control, and Automaticity

Goals, Attention, and (Un)Consciousness
Ap Dijksterhuis and Henk Aarts 467

Bargaining, Negotiation, Conflict, Social Justice

Negotiation

Leigh L. Thompson, Jiunwen Wang, and Brian C. Gunia 491

Personality Development: Stability and Change

Personality Development: Continuity and Change Over the Life Course

Dan P. McAdams and Bradley D. Olson 517

Work Motivation

Self-Regulation at Work

Robert G. Lord, James M. Diefendorff, Aaron C. Schmidt, and Rosalie J. Hall 543

Cognition in Organizations

Creativity

Beth A. Hennessey and Teresa M. Amabile 569

Work Attitudes (Job Satisfaction, Commitment, Identification)

The Intersection of Work and Family Life: The Role of Affect

Lillian T. Eby, Charleen P. Maher, and Marcus M. Butts 599

Human Factors (Machine Information, Person Machine Information, Workplace Conditions)

Cumulative Knowledge and Progress in Human Factors

Robert W. Proctor and Kim-Phuong L. Vu 623

Learning and Performance in Educational Settings

The Psychology of Academic Achievement

Philip H. Winne and John C. Nesbit 653

Personality and Coping Styles

Personality and Coping

Charles S. Carver and Jennifer Connor-Smith 679

Indexes

Cumulative Index of Contributing Authors, Volumes 51–61 705

Cumulative Index of Chapter Titles, Volumes 51–61 710

Errata

An online log of corrections to *Annual Review of Psychology* articles may be found at <http://psych.annualreviews.org/errata.shtml>