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Social dynamics in the preschool

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Abstract

In this paper, we consider how concepts from dynamic systems (such as attractors, repellors, and self-organization) can be applied to the study of young children's peer relationships. We also consider how these concepts can be used to explore basic issues involving early peer processes. We use the dynamical systems approach called state space grid (SSG) analysis and consider how it can be expanded beyond the study of dyads to the study of larger social groups and networks. In particular, we explore the role of homophily—that is, behavioral and sex similarity—as factors in the self-organization of young children's social groups. A dynamic systems approach allows for consideration of peer processes difficult to assess using more traditional approaches.

Keywords: Peer relations; Dynamic systems; State space grids

Introduction

Although it may not be apparent at first glance, children in a preschool class illustrate many interesting patterns of social organization. Even as they chase one another, ride tricycles, build and destroy block houses, hit each other, and move in and out of social play, there are patterns in the apparent disorganization of these behaviors. Closer scrutiny reveals that certain children consistently tend to play together, other children play with many different peers, and a few others tend to play alone much of the time. In this paper,

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we ask and attempt to answer a question central to these patterns; "what brings young children together as play partners?"

Our question reflects a fundamental issue in the social sciences (e.g., Macy & Willer, 2002): how do separate individuals, each with their own personalities and behavioral characteristics, organize over time into coherent clusters? This question takes on additional complexity when considering developmental changes that may influence the organization of children's social groups, such as the development of social, regulatory, and communication skills. The dynamic systems (DS) perspective provides a framework for examining issues of complexity, change, and self-organization. Despite recognition of the complexity involved in understanding human social systems, researchers interested in social development have only recently begun to employ dynamic systems approaches—and this is particularly true for young children's social development. The purpose of this paper is to explore the utility of a dynamic systems approach for investigating young children's social interactions.

In natural contexts such as classrooms or playgrounds, where obtaining detailed and continuous data on social interactions is demanding, it is difficult to capture the dynamics of social interactions. As such, a common strategy employed by researchers is to focus attention on individual characteristics of dyads or group members and to use static assessments of these dyads or groups at one or two points in time (Gest, Farmer, Cairns, & Xie, 2003; Kindermann, 1993; Martin & Fabes, 2001). Although interesting insights into peer group socialization have come from these studies, they do not inform us about the dynamic processes that may best explain how these groups evolve and change over time (Schmidt, Hanish, Martin, & Fabes, 2005).

Until recently, our own research could also be characterized by these limitations. However, the development of observational coding procedures that allow us to collect vast amounts of data on children's social behaviors and peer interactions combined with the application of recent advances in dynamic systems methodologies permit the analysis of children's peer socialization processes in greater depth than has heretofore been possible. Using handheld computers, our trained observers collect tens of thousands of observations of preschoolers' social behaviors and peer interactions over the course of the school year. The observations reflect a *geo-social* (by which we mean the spatial distribution of human activity and interaction) and temporal organization of children's peer interactions at preschool and provide information about the social organization of the classroom and school. As such, each observation is part of the representation of the social dynamics for a child at any given moment in time. Using DS methods to examine observations over time reveals the patterns and the processes that underlie these dynamics.

In this paper, we consider how dynamic systems concepts can be applied to the study of peer processes involved in the development of young children's peer groups. We employ one dynamical systems approach in particular, namely, state space grid (SSG) analysis (Granic & Hollenstein, 2003; Lewis, Lamey, & Douglas, 1999), and consider how it can be expanded beyond the study of dyads to the study of groups. Emphasis is placed on providing insights into the role of homophily—the process of selective affiliation with similar others (McPherson, Smith-Lovin, & Cook, 2001)—as a factor in the organization of young children's social groups. DS perspectives allow for consideration of multiple forms of homophily and provide insights into changes over time in various types of homophily. Before providing background on basic DS ideas and how they have been successful in understanding social development and peer processes, we first review literature on children's social systems and the factors believed to influence the organization of these systems.

Homophily and sex segregation in young children's social systems

Preschool is a particularly interesting time to study social organization. In the US, approximately 12 million children under the age of 5 years attend some type of preschool (Yarosz & Barnett, 2001). Preschools are primarily designed to emphasize learning through play activities. In these play-based activities, children spend much of their time engaged in relatively unstructured activities that provide opportunities for peer interaction. For most children, preschool is their first opportunity to have extended contact with many different same-age peers. In addition, during the preschool years important changes take place in the general pattern of social behavior. Specifically, the preschool period is a time when children move from a general tendency to play alone or along side other children towards increasing levels of true social interactive play (Rubin, Bukowski, & Parker, 1998). Thus, over the course of preschool, we often see the emergence of social behaviors that reflect an orientation towards affiliation and engagement with peers.

The transition to a peer orientation is more difficult for some children than others. Children who are shy, inhibited, socially unskilled, or dysregulated may find this preschool transition particularly aversive or stressful. For example, Watamura and colleagues (Watamura, Donzella, Alwin, & Gunnar, 2003; Watamura, Sebanc, & Gunnar, 2002) found that cortisol (a stress-sensitive hormone) levels rose across the day at child care, but not in the same children when they were at home. This increase was more dramatic for toddlers and preschoolers than infants and more dramatic for socially inhibited children. Although the processes that account for such rises are unclear, we speculate that the highly social nature of peer interactions at preschool increases the social stressors that children face. How preschoolers react and respond to these social challenges may set the stage for development of behaviors and attitudes related to peer interactions and management of social networks and groups. Thus, the preschool period may be a time when children are particularly responsive to the peer system, making it a rich time to investigate the dynamics of early social interactional development.

Sex segregation

Homophily is important in the origins and dynamics of children's social organizations (Rubin, Lynch, Coplan, Rose-Krasnor, & Booth, 1994). There are many dimensions that reflect homophily: people form networks with others who are similar to themselves on sex, race, status, values, attitudes, and behaviors. Children tend to "flock" to others who are similar to them in race, sex, and behaviors (Hanish, Martin, Fabes, Leonard, & Herzog, 2005; Rubin et al., 1994; Shrum, Cheek, & Hunter, 1988), but the strongest and earliest evidence of homophily is the pattern of sex-based preferences for interactional partners, referred to as sex segregation.

By most estimates, over half of young children's peer interactions involve play with same-sex peers, approximately 1/3 involve mixed-sex peers (playing with both a boy and a girl), and about 15% involve play only with other-sex peers (Martin & Fabes, 2001). Children show early and strong preferences for same-sex play partners (Martin, Fabes, Evans, & Wyman, 1999; Ruble & Martin, 1998). These preferences begin between 30 and 36 months and increase across childhood (La Freniere, Strayer, & Gauthier, 1984; Maccoby & Jacklin, 1987; Serbin, Moller, Gulko, Powlishta, & Colburne, 1994). Cross-cultural research confirms the ubiquity of this sex-segregated pattern of social interaction among children (Carter, 1987). The extent of this sex difference is exceptionally strong. For example, in most studies of sex differences in behavior, sex accounts for less than 5% of the variance. In contrast, for choice of play partner, sex accounts for 70–80% of the variance (Martin & Fabes, 2001). Not surprisingly, sex segregation has been identified as one of the most pervasive and powerful developmental phenomenon (Maccoby, 1990).

Understanding sex segregation is important because it is central to the social organization of children's peer group interactions and because sex-segregated interactions exert powerful socialization forces in children's lives (Leaper, 1994; Maccoby, 1990, 1998; Martin & Fabes, 2001). As girls play with other girls, they are exposed to the play styles and interactional styles of other girls, such as playing quietly, being cooperative, and playing in smaller groups. Similarly, as boys play with other boys, they are exposed to boys' play and interaction styles, such as dominance orientations, playing with high levels of activity, and engaging in forceful, rough and tumble play (Maccoby, 1998). These forms of socialization can be considered so different that they have been described as separate social worlds or "two cultures" (see Maccoby, 1998). Although this view may exaggerate the differences (Underwood, 2003), most social developmentalists acknowledge that children's behavior is shaped over both the short- and long-term by exposure to same-sex peers (Gest et al., 2003; Harris, 1995; Kindermann, 1993; Leaper, 1994; Maccoby, 1990, 1998; Martin & Fabes, 2001).

Given the strength of sex segregation, it would be easy to conclude that the "large" effect of sex segregation results from the widespread and extreme bias in favor of one's own sex. However, research on animal and human social groups suggests that relatively small forces can produce large changes, those that increase the level of complexity in social systems. In real-world and simulation demonstrations of racial, ethnic, or economic segregation occurring in neighborhoods, even small individual actions within a group may create unexpectedly strong results (Hegselmann & Flache, 1998; Sakoda, 1971; Schelling, 1971). For instance, when group members do not hold high levels of prejudice but instead have minor preferences for same-race neighbors, segregation in neighborhoods is still very high. The individual and low-level preferences of group members act to form a powerful and strongly organized group pattern of segregation. In the same manner, a relatively minor "pull" toward same-sex peers or a minor "push" away from other-sex peers might translate into high levels of same-sex play. The idea that small individual actions can greatly influence outcomes at higher levels of organization within a social system is consistent with dynamic systems principles.

Furthermore, these small pushes and pulls on the social system become magnified and intensified over time, resulting in new levels of organization. The organization of the social system at preschool involves changes that occur over relatively long periods of time (over months of preschool) and changes that occur over relatively short time periods (days). Thus, we expect that sex segregation and the resulting social groups are stable and fluid. Empirical research provides support for these contentions. Sex segregation appears to have some stability in that certain children appear to engage in this type of play more than others (Martin & Fabes, 2001); at the same time, sex segregation varies across different situations (Lloyd & Duveen, 1992; Maccoby & Jacklin, 1987), such as it decreasing when teachers encourage boys and girls to work in an area together.

Changes may occur through perturbations to the peer system. Any open system is vulnerable to perturbations or changes in the system, and this idea is a central concept within dynamic systems theory. In the case of the preschool classes, perturbations have the potential to change the dynamics of sex segregation, for instance, a child who drops out of the program may shift the play dynamics in ways that could affect another child's overall level of sex-segregated play. Holidays, new children entering a class, field trips, and new playground equipment may all act as perturbations to the preschool social system and may influence patterns of sex segregation.

The role of homophily in children's sex segregation

The leading explanation for sex segregation has been behavioral compatibility or similarity (Maccoby, 1994; Serbin et al., 1994). Compatibility in sexually dimorphic activity choices or playstyles may draw children together into play groups of same-sex peers (Goodenough, 1934; Maccoby, 1998; Urberg & Kaplan, 1989). Specifically, it is presumed that children who share similar behavioral tendencies will congregate together and that dissimilar children will not be drawn into these interactions and may actively avoid them (Fabes, 1994; Haskett, 1971; Serbin et al., 1994). For instance, since boys tend to be more active than girls, if children congregate according to activity level, their play patterns will be sex segregated. However, it is important to note that behavioral similarity on *non-sexually dimorphic* dimensions would not draw children into same-sex groups, although it may draw children into groups based on other characteristics. Thus, it is the link between the sex-differentiated nature of the behavior, and the tendency to be drawn into play with others who share the same playstyles, that would produce sex segregation.

One issue that has not been clearly addressed is whether behavioral similarity on sexually dimorphic dimensions alone accounts for sex segregation. That is, are the characteristics that draw children together sufficient to account for sex segregation or do children also consider the sex of the child in making play partner choices. As Maccoby wondered (1994, p. 90), "is a girl made wary by the vigorous approach of *any* potential play partner, regardless of the child's sex, or only by such an approach from a boy? Is a boy pleasantly excited by the vigorous approach of any child, or only when the approaching child is male?" In this question, Maccoby is asking whether behavioral similarity alone is enough to account for sex segregation. If it is not, then we would see that sex of the partner may matter above and beyond playstyle similarity (Hoffman & Powlishta, 2001). If the sex of the potential partner matters, then behavioral compatibility alone would not be a sufficient explanation of sex segregation.

Experienced and expected homophily

In addition to behavioral similarity (on sexually dimorphic behaviors), we also believe that children's beliefs about the sexes contribute to sex segregation. That is, we argue that both behavioral similarity and gender-based beliefs about the sexes work together to produce the social organization we observe in children. Another way to think about these potential explanations is that there are at least two types of homophily central in the organization of children's social worlds: experienced similarity and expected similarity. Experienced homophily is essentially equivalent to behavioral similarity on sexually dimorphic behaviors in that children can experience homophily when they interact with or observe a peer who behaves in a similar fashion to themselves. For instance, a child who is very active would experience homophily interacting with another highly active child. In contrast, expected similarity is based in children's beliefs or cognitions about others. Expected similarity arises when children hold the belief that one type of child is likely to share similar characteristics with them.

Children's gendered beliefs may give rise to expected homophily (Martin, 1994; Powlishta, 1995). Even before obtaining information about a potential playmate's actual behavior and interests, a child may hold expectations about another child sharing similar interests based only on his/her sex, and these expectations may provide an impetus for same-sex play. For most children, we expect these beliefs to be evident by preschool as they develop basic notions about gender at an early age (Martin, 2000; Martin & Ruble, 2004; Martin, Ruble, & Szkrybalo, 2002, 2004). By age 3, virtually all children develop gender identity and can label themselves and others by sex and soon after they draw inferences about same-sex similarity and other-sex differences (Martin, Eisenbud, & Rose, 1995). Of course children may also draw inferences from experienced homophily with one sex; that is, a child who has played with very active boys may then assume that other boys are likely to be very active. Thus, we view experienced and expected homophily as being compatible with one another and as functioning conjointly to shape the interactional system in the preschool (Barbu, Le-Maner-Idrissi, & Jouanjean, 2000).

Exploring temporal changes in types of homophily should provide insights into social processes. Given the nature of the differences between expected and experienced homophily, we might expect that these two forces would play out differently in the formation of sex-segregated social groups. By their very nature, expected similarities could be acted on immediately whereas experienced similarities require time before the child can evaluate similarity. We would expect children to exhibit a general tendency to interact with peers of the same-sex and we expect that these patterns would occur relatively early in their interactions. In contrast, children's attraction to other children with similar behavior (or perceived similar behavior) will take more time to develop as they must engage in a variety of interactions (or observe those interactions) before being able to draw conclusions about the playstyles of others. That is, children do not require experiences with others to apply their beliefs about the sexes, whereas they do need such experiences to determine behavioral similarities.

In summary, sex segregation is one of the most significant developmental phenomena that has been identified, and yet little is known about how this type of social organization develops, how it is maintained, and how it changes over time and context. Dynamic systems perspectives provide the conceptual and methodological tools to enable researchers to better understand and explore the development of this important form of social organization. Rather than considering only the grandest accounts of sex differences as potential explanations for segregation, DS perspectives encourage thinking about the smaller forces that may push and pull the behavior of many individuals into patterns organized at higher levels. We now examine these ideas in more depth.

Dynamic systems and self-organization

A dynamic system has been defined as a system of elements that change over time (Thelen & Smith, 1998). A dynamic system is more than a collection of elements; rather, it is the *interactions* among these elements that create the system (Fogel et al., 1992). In DS terms, the order of a system emerges spontaneously from interactions among lower-order elements in a process known as *self-organization*. Self-organizing, dynamic systems form stable patterns that are not pre-programmed or directed by an external agent but arise from the cooperative activity among the lower-order elements. Self-organizing processes have been identified in patterns of stability and change in a wide range of domains including animal populations (Murray, 1989), lasers (Haken, 1987), brain activity (Freeman, 1995), and chemical reactions (Belousov-Zhabotinsky reaction). Developmentalists have been particularly interested in self-organization because it can account for both stability and the emergence of novel forms. Before reviewing some developmental applications, we will first elaborate a few of the DS principles common to all self-organizing systems.

Dynamic systems can only be modeled, measured, or otherwise understood over a period of time (Granic & Hollenstein, 2003). The interactions among lower-order elements that create the state of the system are constantly in flux. These fluctuations can be tracked in real time and, given a sufficient length of observation, can reveal the stable patterns of the system. However, there is also a progression of change that occurs over longer periods of time. Thus, the real-time patterns of dynamic systems can also be tracked over developmental time. Indeed, it is this relationship between these time scales that is at the center of DS approaches to developmental phenomena. For example, real-time patterns of children's social exchanges may be relatively stable at any given age, yet new qualities of these exchanges emerge throughout development. Thus, the interactions among lower-order system elements in real time give rise to both stability and change.

Over time, self-organizing systems become more ordered and complex (Lewis, 2000). This order and complexity are a function of several processes that operate at the real-time scale and in the relation between real- and developmental-time scales. In real time, relations among lower-order system elements at the same level are reciprocally causal. This reciprocity occurs through processes of negative and positive feedback that govern the interactions among elements. Negative feedback processes are self-stabilizing. Through negative feedback the elements continue to be linked in a similar fashion over time and the stability of the system is maintained. Positive feedback amplifies small variations in the lower-order interactions to create system instability. This instability is necessary to break down old patterns and allow novel forms to emerge in their place. The dynamics of a system are the result of the interplay of both positive and negative feedback processes.

The order and complexity of a self-organizing system increase over time through the coordinated coupling of system elements and the interaction of positive and negative feedback processes (Granic, 2000; Lewis, 2000). Real-time interactions may give rise to novel forms, but the system also loses degrees of freedom over developmental time as certain patterns become more crystallized and others become less and less probable. Thus, macro structures emerge as products of local interactions and these structures recur and persist over developmental time. In this way, the relationship between real- and developmental-time scales manifests in the organizational structures of the system. This interaction between scales is an example of circular causality (Haken, 1987). That is, "a higher-order form *causes* a particular pattern of coupling among lower-order elements, while this pattern simultaneously *causes* the higher-order form" (Lewis, 2000, p. 40). Examples of circular causality can be found throughout the natural world: cycles of predator–prey populations (Murray, 1989), synchronization of basic brain-stem functions yielding higher-order cortical processes (Freeman, 2000; Lewis, 2005), coordination of limbs during walking (Thelen & Ulrich, 1991), and flocking behavior of migrating birds (Couzin & Krause, 2003).

Human social development also may progress in a similar fashion due to feedback processes and circular causality. Although research is limited in this area, there are several studies that indicate that the orderliness of social interactions stabilizes over development. Many DS studies that relate real-time social interactions to developmental trajectories have focused on infancy (e.g., Fogel, 1990; Hsu & Fogel, 2003). For example, early socio-emotional patterns of attention and distress become more organized from 2 to 6 months of age (Lewis et al., 1999). Some studies have examined patterns of real-time stability and change across development through investigations that span a developmental transition. Although a self-organizing, dynamic system becomes more ordered over time, changes in the macro structures are possible and sometimes necessary for further development. The structure of a system can be reorganized through the process of a phase transition—a period of temporary instability or variability when one stable pattern breaks down and another emerges in its place. In one study, the stable socioemotional habits of infants at 14–15 months became temporarily unstable during the 18-month transition but restabilized a few months later (Lewis, Zimmerman, Hollenstein, & Lamey, 2004). Likewise, the real-time variability in parent–child interactions has been shown to peak at the onset of early adolescence before restabilizing in mid-adolescence (Granic, Hollenstein, Dishion, & Patterson, 2003). Dishion, Nelson, Bullock, and Winter (2004) also showed that real-time peer interactions became more organized and less variable from mid- to late adolescence. These studies have begun to demonstrate the self-organizing relationship between real-time social interactions and developmental macro structures.

As described earlier, the socialization processes of homophily in young children may also be framed in terms of local, real-time interactions that give rise to more stable global social structures over time. In preschool, for example, children are immersed in a setting where social structures have not yet formed. Through the course of interacting with one another and iterative positive and negative feedback processes, expectancies and preferences emerge. Thus, early peer experiences may start out as a more variable pattern of interactions that eventually coalesce and organize as children become more discriminating about their play partners. Once these social structures have developed, they exert influence on the moment-to-moment interactions among peers and complete the loop of circular causality.

It is relatively easy to make the theoretical or conceptual connection between socialization processes and properties of dynamic systems. However, testing this theoretical connection requires an equally novel methodological approach. DS developmentalists have recognized that it is first necessary to map system dynamics in real time (e.g., Lewis et al., 1999). The SSG technique was developed by Marc Lewis and colleagues as a way of tracking the real-time dynamics of behavior for DS analyses. SSGs have been used in a variety of studies to explore interactions, usually between two actors, such as an adolescent and his/her parent or a mother and her child (Granic & Dishion, 2003; Granic & Lamey, 2002; Hollenstein, Granic, Stoolmiller, & Snyder, 2004). We have adapted this technique to the study of peer socialization dynamics. Before describing this work, the SSG method is detailed below.

State space grid analyses

One of the most prominent characteristics of a dynamic system is that despite a large number of possible patterns among system elements, only a few ever stabilize. These recurring, stable patterns are called *attractors:* "absorbing" states that "pull" the behavior of the system from other potential states. Thus, over the course of many moment-to-moment interactions among the system elements, an attractor is a highly probable state of the system. Other states are highly improbable and these are termed *repellors*. The configuration of attractors and repellors comprises the *state space* of a system. This hypothetical space includes all the possible states of a system and is often depicted as a topographical landscape. Fig. 1 shows a three dimensional space with several valleys (attractors) and peaks (repellors). The behavior of the system (i.e., series of states) is traceable as a trajectory that moves around the state space (often represented as a marble rolling in and out of the attractor basins). Moreover, the "strength" or probability of attractor states can vary. A repellor (see area D in Fig. 1) is a state that is highly improbable and from which behavior escapes to other states. Metaphorically, deep attractors with wide basins correspond to greater "pull" and higher probability and trajectories require more energy to exit these states (see attractors A–C in Fig. 1). Examples of attractors in human systems include depression (e.g., Johnson & Nowak, 2002) and entrenched patterns of interaction in parent–child dyads (e.g., Granic & Lamey, 2002), marital couples (e.g., Gottman & Notarius, 2000), and peer dyads (e.g., Granic & Dishion, 2003).

Based on these DS concepts, SSGs are two-dimensional grids constructed from the intersection of two categorical or ordinal variables. These grids comprise the state space of the system representing all possible combinations of the two variables. For example, the *X*-axis could represent mutually exclusive and exhaustive categories of emotions for one child, and the *Y*-axis could represent the emotion categories for another child. When these two children interact, the sequence of dyadic emotional states (i.e., trajectory) is plotted as it proceeds in real time on a grid. Each cell of the grid represents the simultaneous intersection of each dyad member's behavior. As shown in Fig. 2, Child 1's coded behavior is plotted on the *x*-axis and Child 2's behavior is plotted on the *y*-axis. Any time there is a change in either person's behavior a new point is plotted in the cell representing that joint behavior and a line is drawn connecting the new point and the previous point. Thus, the grid represents a sequence of dyadic events.

A hypothetical trajectory representing 15 events of a peer interaction is presented in Fig. 2. The state space is formed by the intersection of an ordinal set of affect categories for both children: high negative, low negative, neutral, low positive, and high positive. The sequence depicted begins in the mutually Low Positive cell followed by 3 events in the Child 1 Low Positive/Child 2 Low Negative cell, 4 events in the mutually Low Positive cell again, 2 events in the Child 1 Neutral/Child 2 Low Positive cell, 2 events in the Child 1 Neutral/Child 2 High Negative cell, and finally 2 events in the mutual High Negative cell. The sequence of events depicted by this trajectory suggests that Child 2 may have been goading the seemingly affable Child 1 through negative behavior. Eventually, Child 1 responds in kind and the interaction ends in mutually high negativity, indicating a conflict has ensued.

GridWare 1.1 (Lamey, Hollenstein, Lewis, & Granic, 2004), the program used to generate the SSGs for our research (and to produce the figures), also exports several measures

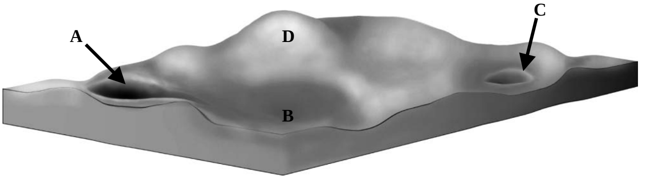

Fig. 1. Example of attractors and repellors in SSG.

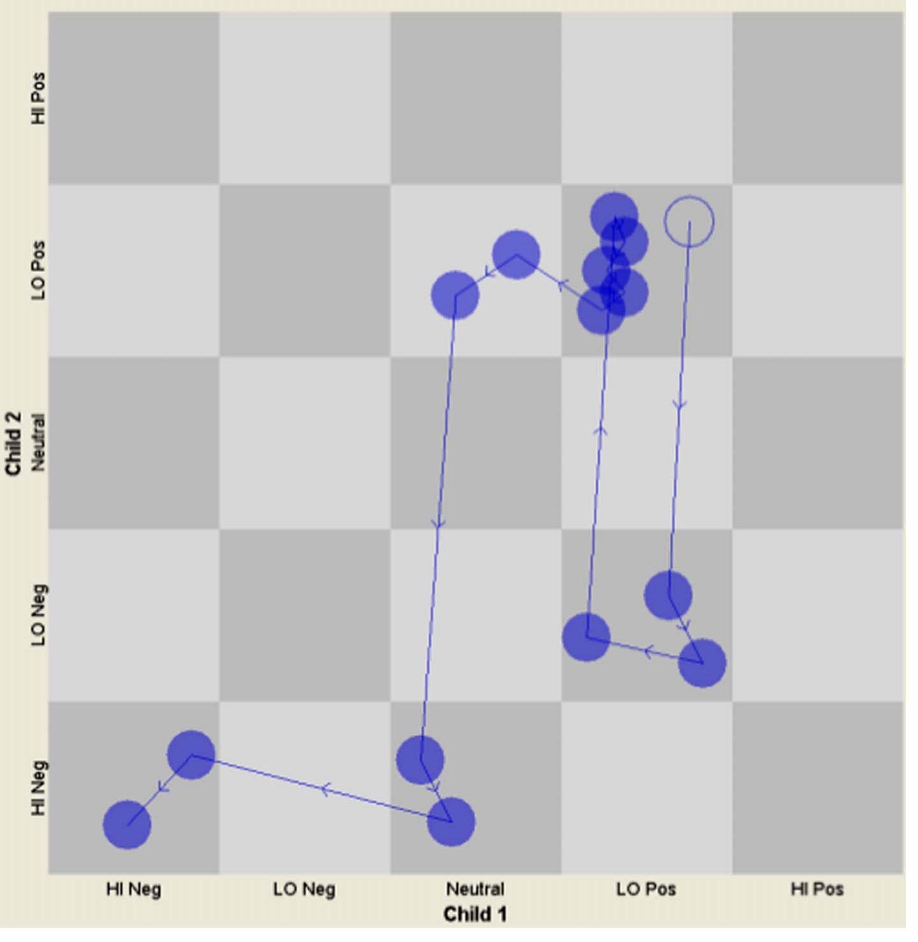

Fig. 2. Example of a dyadic SSG.

that index the behavior within an individual cell, a region of several cells, or across the entire state space. The presence and strength of attractors as well as the overall behavioral organization across the state space can be derived from these measures. The measures used in the examples presented here are summarized in Table 1.

Using state space grids to explore the nature of young children's social interactions

In the following sections, three broad topics about young children's social interactions will be addressed using SSG analysis. First, a description is provided of how we modified SSGs for use with complex naturalistic peer interactional data, and of the types of SSG measures that will be examined. Second, we use SSGs to illustrate and assess both sex- and behavioral similarity. Third, we use SSGs to assess temporal patterns for each type of similarity. Finally, we consider how micro-level processes occurring between peers relate to social organization using SSGs in which we analyze interactions between children and same- and other-sex peers.

Table 1
Description of state space grids measures

Measure	Description	Meaning of high values
Cells	Number of cells visited by the trajectory	High variability, low stability
Events	Number of discrete observed events in a cell or region	Strong attraction
Visits	Number of returns to a cell or region (one Visit may include several repeating events)	Strong attraction
Ratio	(1 – Visits/Events): Composite index of the "stickiness" of a cell or region	Strong attraction
First entry	Time of the trajectory's first entrance into a cell or region	Strong attraction
Return time	Time or events between 2 Visits to a cell or region	Weak attraction

Using SSGs to illustrate peer processes

We have applied SSG methods in several ways to the study of early peer processes. The first challenge was to extend SSGs beyond one-to-one dyadic interactions to group behavior. As described above, the typical dyadic method is to graph one child's behavior against another child's (or adult's) behavior, so that each of the two dimensions of the grid represents one person's behavior. To describe a larger social landscape, we had to find ways to represent more than one person on one of the axes. One solution to this challenge was to analyze *types* of peers on the axes. For instance, rather than considering how one child interacted with another single child, we analyzed how a child interacted with same-sex and other-sex peers and/or with children who varied in their style of behavior (socially competent, externalizing, and internalizing).

In these analyses, we created several variables that can be used in SSG analyses to address questions about the nature of young children's social interactions in preschool. To do this, we utilized observational data obtained with either of two observational procedures that have proven to be reliable—scan observations and focal observations (Fabes, Martin, & Hanish, 2003; Fabes, Shepard, Guthrie, & Martin, 1997; Martin & Fabes, 2001). Scan observations were conducted by observing each child (in a randomly ordered sequence) in a class for 10 s. During each observation, the observer made note of the child's social behavior, including the peer(s) he/she was interacting with (if any) and the target child's behaviors and affective expressions. Because the observers repeatedly rotated through the observation list over the course of the school year, hundreds of observations were obtained over time for each child in the class. This method allows for many observations of children and reflects the geo-social patterning of children's social interactions. These observations are not gathered contiguously in time, however. Instead, the time intervals between each observation vary. Nonetheless, these observations are sequentially ordered and useful for mapping peer processes that occur over an extended period of time (i.e., months), that is, over developmental time. Furthermore, any single scan observation may include multiple peers but only one can be entered into the SSG to represent each individual event. Thus, we elected to use the primary interactive partner if multiple peers were coded during the observation interval.

Focal observations were conducted by observing a target child over a 10-min period. During each observation, the observer noted the target child's actions and the responses to these made by the child's primary peer interaction partner in each interaction. Because peers' contingent responses to the target child can be identified with this observational procedure, this method can be used to map contingent peer socialization processes that occur over brief time periods (i.e., minutes). Together, both observational methods provide data that speak to peer processes that occur over real- and developmental-time.

It is important to note that the SSGs plotting target children's interactions with primary peers mark several significant departures from the typical use of SSGs in which dyads are examined as they interact over time. First, by selecting primary peers, we are attempting to arrive at a holistic picture of the "group" of peers a child interacts with rather than targeting only one peer at a time. The disadvantage of this method is that we are unable to ascertain in the SSGs how many peers were involved with a particular target child (i.e., it could be one peer repeatedly or many different peers). Second, by collecting observations over an extended period (a school year), we attempted to construct a broader picture of peer relationships. These departures provide different and valuable information about the broader context and temporal changes in children's social development, and can be used in conjunction with dyadic assessments, which capture interactional processes more completely.

Several state space measures were used to assess whether particular regions of the state space landscape could be considered attractors (see Table 1). Imagine a SSG for a particular child with sex of peer (same-sex, other-sex peer) on the x-axis and type of peer (competent, externalizing, internalizing) on the y-axis (see Fig. 3). On the figure, each circle represents a single observation of the target child (a boy), and the placement of the circle on the grid represents the type of child with whom the target was seen interacting (what we are calling a "geo-social" representation). The most central SSG measure for our purposes is the number of events in each region. For instance, we can compare the number of events in the same-sex versus other-sex regions of the grid, which corresponds to the number of

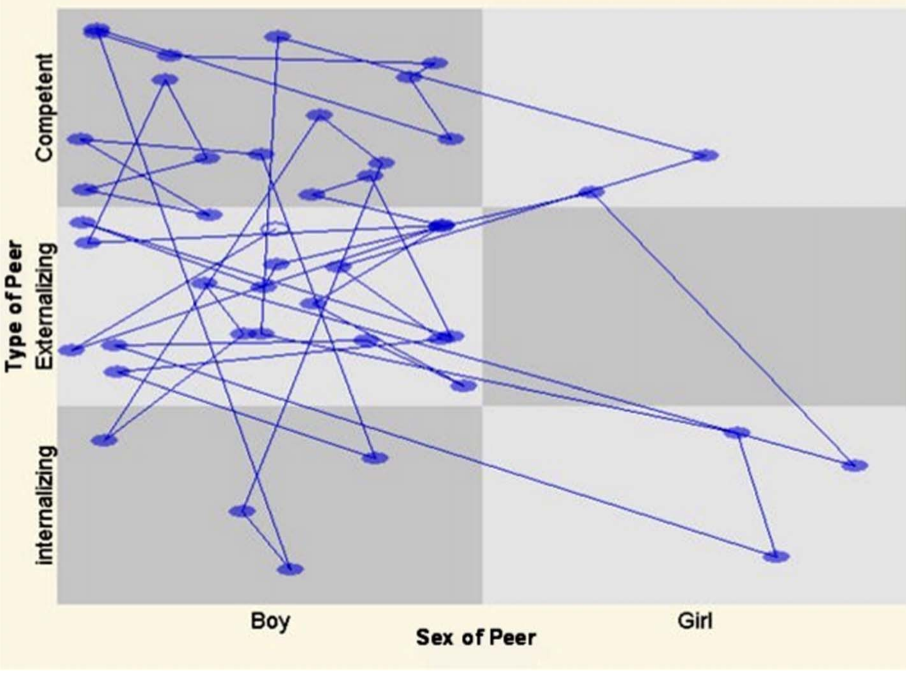

Fig. 3. SSG for One Target Boy.

times a child was seen interacting with same-sex or other-sex peers. Number of visits indicates the number of times a child returns to a region. In addition, we examined how quickly the child first entered a region (first entry), with the assumption that an attractor draws behavior to it quickly whereas a repellor would be a region that a child avoids (thus enters later). We also examined how quickly the child returned to a region (return time). A child who has a high return time to a region may be exhibiting either a weak attraction or, in extreme cases, repulsion from this region. Finally, we constructed a "stickiness" ratio that considers the number of visits relative to the number of events (e.g., 1 − the ratio of visits/events), in which a higher number indicates a "stickier" region. The number represents the likelihood of staying in a region. Children who have many events and few visits are showing an increased likelihood of staying in a region once having entered it, thus this "stickiness" ratio provides another indicator of the strength of an attractor. In contrast, a child who has many events and many visits to a region is showing that he has little likelihood of staying in a region after entering it; thus, this would be consider either a very weak attractor or, at the extreme, it could be a region of repulsion.

Prototypic illustrations of sex segregation

Imagine a perfect case of sex segregation: in every peer interaction, boys would only be seen playing with boys, and girls would only be seen playing with girls. The geo-social topography of the state space for children's peer interactions would show two deformations: one very low dip—the same-sex attractor—that draws or pulls behavior into a steady state of same-sex play; and a very tall peak—the other-sex repellor—that pushes behavior away from other-sex play. In this perfect case, both of these deformations are monumental in metaphorical size—the dip is essentially a Grand Canyon; the peak is Mount Everest. Gravity would require very little energy to force a behavior (a child's play partner preference) down into the Grand Canyon but an incredibly strong force would be required to push a behavior all the way up to the top of the mountain. Of course, the topography of children's social landscape is rarely that extreme. In the following sections, we explore the wider-ranging differences between children's social state spaces.

Behavioral homophily: Is it sufficient to account for sex segregation?

In this section, we use Maccoby's question about the roles of behavioral homophily and sex of partner in children's sex segregation to derive a similar question about children's broader social systems. Specifically, we were interested in exploring how behavioral similarity (experienced homophily) and sex similarity (which may be influenced by expected homophily), help to shape children's social organization. We did this by examining SSGs based on observational data from three classes of preschoolers ($n = 59$) in two preschools mainly serving middle-class families. The children ranged in age from 37 to 64 months ($M = 49$ months) with 34 boys and 25 girls. Approximately 63% were Caucasian and 10% were Hispanic. Data from three children were dropped because of low numbers of observations, resulting in SSGs developed from 33 boys and 23 girls.

The SSG method involved plotting each 10-s scan observation of social interactions as to the sex of primary peer involved (boy, girl) and behavioral tendency exhibited by that peer over the course of the term (e.g., socially competent, $n = 22$; externalizing, $n = 19$; internalizing, $n = 15$; these groupings were determined by cluster analysis of teachers' ratings of children). The reason for selecting these particular behavioral tendencies was twofold. First, rather than mapping children's peer interactions with peers who exhibit varying levels of a specific behavior (e.g., low versus high levels of prosocial behavior), the cluster analysis allowed us to group children according to their scores on multiple dimensions. Second, the cluster groups reflect behaviors that are centrally involved in children's social interactions; thus, they may be good candidates for children's selections of peers. Only the cluster of externalizing tendencies showed a sex difference with boys being more likely to show externalizing behaviors. The use of behavioral dimensions that are not entirely sex-differentiated means that the range of behaviors that were examined were broader than typically discussed as contributing to sex segregation; these allow insights into the broader social organization in the preschool.

Before presenting the actual SSG patterns obtained using our data, let us consider hypothetical examples representing prototypical patterns associated with different explanations of social organization. Fig. 4A represents the state space pattern that might be seen for a socially competent boy who is solely attracted to other socially competent children. If behavioral similarity acts as an attractor, a target child who is socially competent would be seen interacting with other socially competent children, a target child who tends to show externalizing behaviors would be seen interacting with other externalizing children, and a target child who tends to show internalizing behaviors would be seen interacting with other internalizing children—that is, each is drawn to interactions with peers who have similar behavioral qualities regardless of their sex. In this case, the boy's observed interactions cluster together in the region defining socially competent peers, and the sex of the peer is not shaping his landscape. If this pattern occurred, then it suggests that behavioral similarity is an attractor (with these behaviors) and accounts for the geo-social organization for that child.

Fig. 4B illustrates a pattern based on sex similarity. In this case, the events represented on this boy's state space illustrate that he is seen interacting only with boys and it does not matter what type of social behavior they tend to display. This type of sex-based pattern does not inform us about why he chooses boys, it only illustrates that the sex of peers shapes the child's interactional landscape. That is, children's expected homophily may contribute to (or even fully account for) this pattern, but other sex-differentiated factors could contribute or account for the pattern as well. However, if this pattern occurred, behavioral similarity is not enough to account for social organization.

Fig. 4C depicts the interactional landscape for a socially competent boy whose state space is shaped by both similarity on social behavior and on sex. In his case, the events cluster in the region of socially competent boys. If this pattern occurred, it would suggest that behavioral similarity matters but only in consideration for same-sex peers. Why this is the case is not addressed by this analysis.

In analyzing our real data, we first examined patterns illustrating sex-segregated interactions, then behavioral similarity, and then we examined both sex-similarity and behavioral-similarity together. Because we examined a range of measures, these data are presented in tables rather than in SSGs. As can be seen in Table 2, according to the major measures of state space grids that were examined, children were drawn to same-sex more than other-sex peers. Children had many more events in the same-sex regions as compared to the other-sex regions, meaning that they were observed interacting with same-sex peers more than with other-sex peers (for boys, $t(32) = 5.19$, $p < .001$; for girls, $t(22) = -3.06$, $p = .006$). The "stickiness" ratio of visits to events varied systematically, with higher ratios in same-sex regions indicating that once children entered that region, they had a higher likelihood of staying in that region as compared to being observed "staying" in an other-sex region (for

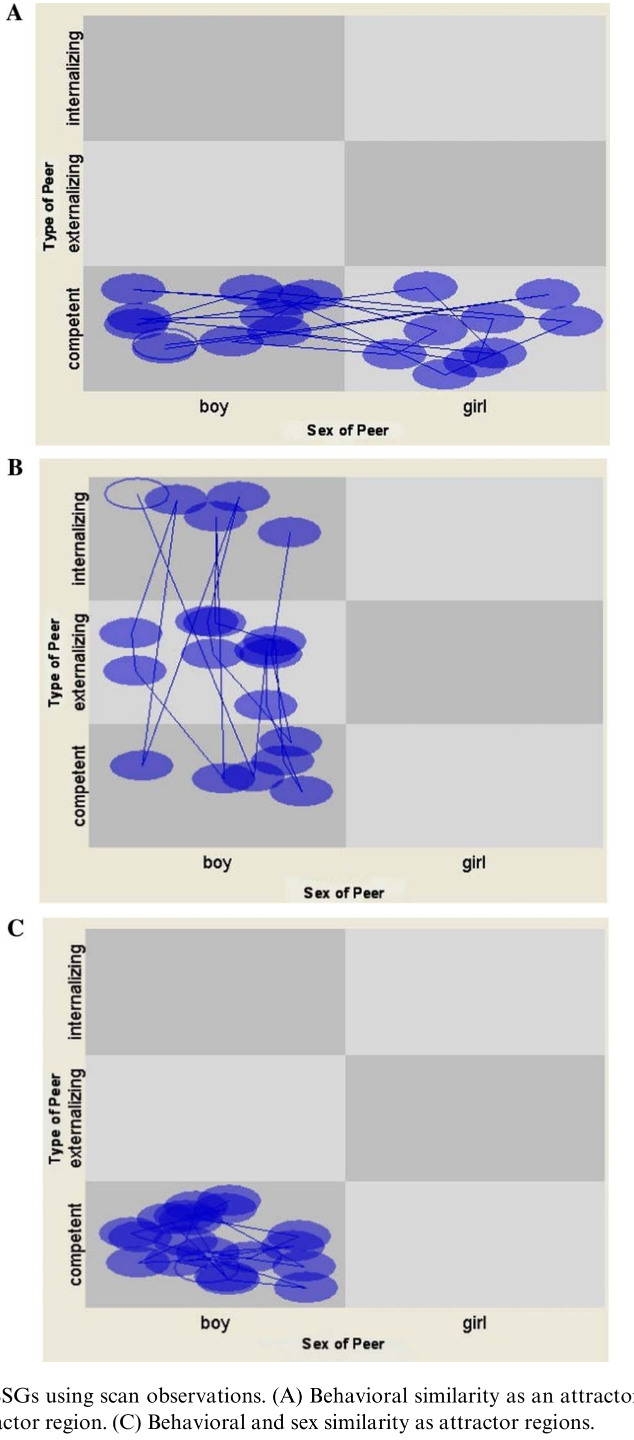

Fig. 4. Prototypes of SSGs using scan observations. (A) Behavioral similarity as an attractor regions. (B) Same-sex peers as an as attractor region. (C) Behavioral and sex similarity as attractor regions.

Table 2
State space indicators of sex similarity and dissimilarity for boys ($n = 33$) and girls ($n = 23$)

	Mean events	Ratio	Return time	First entry
Sex similarity				
Boy with boys	67.6	.79	1.7	1.18
Girl with girls	68.9	.76	1.9	.61
Sex dissimilarity				
Boy with girls	25.0	.45	4.4	4.36
Girl with boys	30.8	.46	3.4	4.83

Table 3
State space indicators of behavioral similarity and dissimilarity for competent ($n = 22$), externalizing ($n = 19$), and internalizing ($n = 15$) children

	Mean events	Ratio	Return time	First entry
Behavioral similarity—target child and peers are similar				
Both competent	79.3	.76	2.5	.59
Both externalizing	53.1	.62	2.8	1.84
Both internalizing	5.1	.24	5.4	16.47
Behavior dissimilarity—target child and peers are dissimilar				
Competent target child with				
Externalizing peers	30.0	.48	4.4	6.28
Internalizing peers	10.3	.26	5.8	45.77
Externalizing target child with				
Competent peers	41.5	.53	3.2	1.90
Internalizing peers	10.5	.27	5.7	25.21
Internalizing target child with				
Competent peers	26.7	.65	2.5	1.87
Externalizing peers	16.1	.46	3.3	2.27

boys, $t(32) = 6.27$, $p < .001$; for girls, $t(22) = -3.51$, $p = .002$). Furthermore, children (trend for boys) first entered same-sex regions about four times more quickly than other-sex regions (for boys, $t(32) = -1.96$, $p = .06$; for girls, $t(22) = 2.36$, $p = .03$), and they returned to those regions quicker than other-sex regions[1] (for boys, $t(32) = -5.92$, $p < .001$; for girls, $t(21) = 3.16$, $p = .005$). Each of these indicators suggests that same-sex similarity was an attractive state for preschool children.

In Table 3, the same indicators were examined in terms of children's patterns of interaction with behaviorally similar children. As you can see, behavioral similarity was more complex than sex similarity in that states of play involving some behavioral styles tended to act attractor-like whereas others did not. When assessing the indicators in cases in which there was matching behavior on the part of the child and peers, matching on either competence or externalizing appeared to be attractor-like. Both showed higher numbers of events with behaviorally-similar peers (e.g., competent targets with competent peers)

[1] Because these observations were conducted as "snapshots" of behavior over time, return time should not be interpreted as the actual passage of time; instead, it is how many events occurred before the child returned to the region.

than with non-similar peers (for competent children, $t(21) = 3.69$, $p = .001$; for externalizing children, $t(18) = 3.29$, $p = .004$). In contrast, internalizing children showed a more repellor-like pattern in which they had higher numbers of events with non-similar peers than with behaviorally similar peers, $t(14) = -3.95$, $p = .001$. Competent and externalizing children also showed faster first entries with similar than with non-similar children (for competent children, $t(21) = -2.72$, $p = .013$; for externalizing children, $t(18) = -2.76$, $p = .013$), and faster return times to interaction with similar children versus non-similar children (for competent children, $t(15) = -3.33$, $p = .005$; for externalizing children, $t(14) = -2.55$, $p = .023$). In contrast, internalizing children showed a more repellor-like pattern with slower return times to interaction with other internalizing children, $t(7) = 2.78$, $p = .027$ (the smaller df is due to children being dropped from the analyses because they did not return at all to the region), and slower first entry to interaction with internalizing children, $t(14) = 2.90$, $p = .012$, compared to interactions with non-similar peers. Interestingly, the stickiness ratio was significant for internalizing children, but suggested that they were more likely to return to interactions with non-similar children rather than with similar children, $t(13) = -4.44$, $p = .001$. In contrast, the stickiness ratio showed the attractor-like pattern for competent children, $t(21) = 2.77$, $p = .012$, and was not significant for externalizing children.

In Table 4, both sex- and behavioral-similarity were considered. Although the patterns were too complex for a complete analysis here, some interesting patterns emerged. For socially competent boys, the strongest attraction was to states of play with externalizing boys. They first entered this region quickly, and returned to this region often. Externalizing girls, in contrast, appeared to be unappealing for these boys. For competent boys, states of play with both competent boys and competent girls were attractor regions. Note that competence appears to be an equal attractor regardless of sex. For socially competent girls, both behavior and partner sex came into play: stronger attraction (i.e., faster return times and earlier entry times) was to states of play with socially competent girls than to states of play with socially competent boys. These girls were more attracted to play with externalizing boys than to play with externalizing girls.

Externalizing boys showed attraction to states of play with other externalizing boys but not to states of play with externalizing girls. They took a relatively long time to first enter the region representing externalizing girls and had many interactions before returning to this type of interaction. Externalizing girls also showed attraction for states of play with other externalizing girls and less so for play with boys, although this was not a repulsive-type region to the same extent as states of play with internalizing children of both sexes. Analyses of the externalizing patterns provide the most direct answer to Maccoby's question. Even considering this sex-differentiated behavior, it was not the case that boys showed preferences for *any* child with externalizing behavior or that girls showed preferences for *any* child who did not show externalizing behavior.

Internalizing children, not surprisingly, had overall lower rates of social interaction, and thus their patterns have to be considered in this context. Internalizing boys interacted more with competent girls, and states of play with internalizing girls and externalizing girls appear to be repulsion-type regions for these children. Internalizing girls interacted at very low rates overall, but more with externalizing boys and competent girls than with other children. Internalizing girls seldom interacted with externalizing girls, had many interactions before entering this region, and were relatively slow to return to it.

Table 4
State space indicators of behavioral and sex similarity and dissimilarity

	Mean events	Ratio	Return time	First entry
Behavioral and sex similarity—target child and peers are similar on behavior and sex				
For boys				
Both competent	19.6	.46	5.2	6.5
Both externalizing	48.7	.58	3.4	1.2
Both internalizing	.9	.00	10.0	38.0
For girls				
Both competent	94.9	.75	2.6	.3
Both externalizing	40.8	.56	3.5	6.8
Both internalizing	5.3	.17	4.4	10.9
Behavior and/or sex dissimilarity—target child and peers are dissimilar on behavior and/or sex				
For competent boys with				
Competent girls	22.3	.39	5.7	6.5
Externalizing boys	39.5	.57	3.1	5.1
Externalizing girls	1.5	.13	9.3	67.5
Internalizing boys	6.1	.28	6.6	31.9
Internalizing girls	4.5	.22	7.5	52.2
For externalizing boys with				
Externalizing girls	3.5	.06	8.3	54.5
Competent boys	31.9	.46	3.9	4.8
Competent girls	13.7	.24	6.6	6.3
Internalizing boys	6.9	.23	6.8	31.8
Internalizing girls	3.5	.11	7.4	64.7
For internalizing boys with				
Internalizing girls	1.3	.23	8.8	47.0
Competent boys	12.4	.36	6.3	1.7
Competent girls	27.1	.62	4.0	2.4
Externalizing boys	15.1	.43	4.4	3.0
Externalizing girls	.6	.00	9.0	47.0
Behavior and/or sex dissimilarity				
For Competent girls with				
Competent boys	21.8	.33	6.2	12.4
Externalizing boys	17.5	.23	5.8	12.4
Externalizing girls	1.4	.07	9.0	116.8
Internalizing boys	3.6	.06	8.5	78.8
Internalizing girls	6.5	.32	5.6	108.7
For externalizing girls with				
Externalizing boys	15.5	.16	4.5	4.8
Competent boys	3.8	.08	8.8	23.8
Competent girls	22.3	.38	5.1	7.8
Internalizing boys	2.3	.13	9.2	56.8
Internalizing girls	8.8	.83	6.1	10.5
For internalizing girls with				
Internalizing boys	2.5	.04	5.7	18.5
Competent boys	4.3	.21	4.5	14.9
Competent girls	11.1	.37	4.0	4.9
Externalizing boys	11.9	.40	3.3	3.9
Externalizing girls	4.6	.28	6.6	7.8

The patterns revealed in these analyses suggest that sex-based homophily was very strong, and that behavior-based homophily varied by type of behavior. When considered simultaneously, the patterns varied by both type of behavior and sex of the target child. Thus, no simple answer can be given to our expanded version of Maccoby's question about the combined roles of sex-similarity and behavioral-similarity as influences on children's social organization in preschool. For instance, competent boys appear to be attracted to interactions with both competent boys and girls; but competent girls were much more attracted to interactions with competent girls than with boys. Internalizing children more than externalizing children were less attractive play partners for children of both sexes. This is surprising given that internalizing qualities probably do not disrupt play as much as externalizing qualities might. The often active and dysregulated play of externalizing children appears to be attractive, especially for boys, but they were much more attracted to externalizing boys than to externalizing girls. And, externalizing children may initiate a lot of contact and may be difficult to reject, even when their play is less appealing. Overall, the findings suggest that both sex of peers and their behaviors help fashion the social organization of the classroom.

Understanding the attractors and repellors for various types of target children provides valuable information about the kinds of peers that children are exposed to during preschool. Of course, no causal explanations can be drawn from these analyses but the patterns are provocative in their implications. If additional analyses showed similar patterns, we could draw several interesting conclusions. First, children vary dramatically in their exposure to different types of peers, especially to competent peers. Although most children may play in sex-segregated groups, the kinds of same-sex peers they are exposed to vary depending on their own qualities (Hanish et al., 2005). Furthermore, although the "two cultures" perspective provides broad descriptions of the types of experiences children may have depending on their sex, this view may need to be expanded to consider multiple types of socialization spheres in preschool classes, that is, *micro-cultures*. Finally, the results suggest that sex segregation may not only be accounted for by behavioral similarity (on the dimensions we assessed) because even when other children are like the target child, states of play and interaction with them may not be attractive unless they also happen to be the same sex. Simple cognitions about the sexes (e.g., "I like others of the same-sex") may contribute to sex segregation by their role in shaping children's expectations about same-sex others. The findings suggest that multiple forms of homophily have to be considered in the development of peer group organization in the preschool classroom.

Temporal changes in sex segregation

In this section, we consider short-term temporal changes in sex segregation. These fine-grained changes should give some indication of the processes shaping the preschool social system. Consider two alternative patterns. If children enter preschool with strong and salient cognitions about sex-based similarity (expected similarity), we would predict that even their earliest interactions would be highly organized around sex of partners. Because sex of partners is obviously marked in most children, little guesswork would be involved in a target child deciding who "should be similar" to him/her. In this case, we would expect to find an early sex-preferential pattern: preferences for same-sex interaction partners may be apparent and consolidated from the beginning of preschool, and these preferences may increase over time. In contrast, if experienced behavioral style similarity (based on sexually dimorphic characteristics) is influencing peer organization, then children would be expected to pay less attention to sex of peers and more to peers' behavior. Because behavioral style similarity requires experience and is not usually apparent in easily discernible markers (as is sex), we would expect to find less organized and more exploratory interactional patterns as they search for peers who are behaviorally similar to themselves. In this case, we may see a pattern in which preschoolers begin the year showing few strong peer preferences but, over the course of the year, such preferences emerge and stabilize.

The data described above allow us to examine some of the changes in sex segregation patterns that occur over the course of the school year, with initial data collected approximately 1 month after the start of the term. In the first 20 interactions obtained,[2] children exhibited clear same-sex preferences, $F(1,53) = 42.24$, $p < .001$, $\eta^2 = .44$, with 70% of their interactions involving same-sex peers. By 40–60 interactions, a small increase in same-sex preferences was apparent (74%) but the change over time did not quite reach significance ($p = .15$).

If sex segregation was not happening early on, then children would show approximately equal return times to the state space region representing other-sex peers as to the space representing same-sex peers. However, they did not. In the first 20 interactions, when return times to same-sex and other-sex regions were analyzed, both boys and girls showed faster return times to same-sex regions ($M = 1.88$) than to other-sex regions ($M = 3.10$), $F(1,44) = 14.67$, $p < .001$, $\eta^2 = .25$, with boys showing significantly faster return times than girls, $F(1,44) = 3.94$, $p = .05$, $\eta^2 = .08$. For children who had complete data over both periods ($n = 35$), return times remained approximately the same over time.

We also explored individual variations in trajectories for different types of children. First, individual differences in levels of same-sex play were assessed for the fall term and children were divided into those who were observed over many periods interacting with same-sex peers and those who were involved in fewer same-sex interactions. Then we asked whether these individual patterns were apparent early in the term, which would be consistent with an expected similarity explanation of sex segregation, or whether they emerged slowly over time, which would be more consistent with an experienced similarity explanation. Children who played more with same-sex peers over the term showed stronger same-sex preferences ($M = 17.0$) even within the first 20 observations as compared with the preferences of the other children ($M = 12.3$), $t(53) = 4.02$, $p < .001$. Children who played more overall with same-sex children showed a trend of increasing in the proportion of same-sex peer events over time (from 85 to 91%; $p = .11$) as compared to low same-sex playing children (63–66%). These findings suggest that some children, possibly the older ones or ones with more childcare or peer experiences, come to preschool with stronger same-sex preferences that are acted upon early in the term. That is, expected similarity may contribute to these children's showing early sex-differentiated play patterns. Furthermore, the moderately positive correlations between early same-sex events and later same-sex events, $r(54) = .53$, $p < .001$, and from early other-sex events to later other-sex events, $r(54) = .47$, $p < .001$, suggest that there is some consistency in these behaviors over time.

[2] The amount of time represented by 20 observations varies by child and depends on their level of social interaction.

Taken together, these and other markers depicting the shape of the social landscape suggest two interesting patterns. First, sex-based organization of interaction partners was relatively strong even early in the preschool year, and for some children, their earliest observed peer preferences were already strongly sex-based. Second, sex-based organization of interactional partners tended to show slight increases over time. Even within a relatively short time frame, children showed some increases in the organization of their behavior, with social interactions falling more into regions of same-sex attraction than into regions representing other-sex peer interactions, although these changes were more apparent for the children who showed stronger interest overall in same-sex peers. These patterns suggest that many children come to preschool with cognitions about same-sex similarity, or they quickly develop these ideas. In addition, the gradual strengthening and the increasing organization of these patterns over relatively short spans of time suggests that other forces, such as behavioral similarity, also shape children's social behaviors. Consistent with DS principles, children's behavior also may become more strongly organized as they are exposed to other children showing strong same-sex preferences, or as they are exposed to other children's (or teachers') explicit instructions about following traditional gender norms for play.

Exploring the nature of same-sex and other-sex interactions

The data we have discussed have been useful for depicting children's overall patterns of interaction with different types of peers, and for examining how these patterns change over time. However, our scan observations were collected at unequally spaced intervals; therefore it is impossible to use these data to draw conclusions about contingent sequences and patterns of responses. For this reason, we rely on focal observations, which provide information on peers' contingent responses to target children's behaviors. Here we present data from a small subset of preschool children ($n = 9$; 5 girls, 4 boys with 19 boys and 16 girls available as peers; over 4 sessions of focal coding). Thus, these analyses provide insight into how dyads interact over time.

Emotional qualities associated with same- and other-sex peer interaction

When children interact, they exchange information, including affective information. The expression of affective states may shape the interactional landscape for young children. Children convey their liking or disliking of the nature of an interaction using emotional displays. When children want to initiate and maintain relations with peers, they may engage in more positive emotions as compared to interactions with peers that they like less. Children may also convey information about the state of the relationship using affective displays; thus, these displays may be used to determine the likelihood of future play with a peer (Schmidt et al., 2005).

To examine children's affective states in same-sex and other-sex interactions, SSGs were formed with the Y-axis representing the sex of peers the child interacted with (boys, girls) and the X-axis representing the target child's emotional displays (high negative, low negative, neutral, low positive, and high positive). As illustrated in Figs. 5A and B, the overall display suggested that children experience more neutral and mid-range affect, and more positive than negative affect in interactions, consistent with other research on dyads (Schmidt et al., 2005). Behavior seldom settled into the areas of high levels of negative affect for either sex. For both sexes, but especially for boys, the range

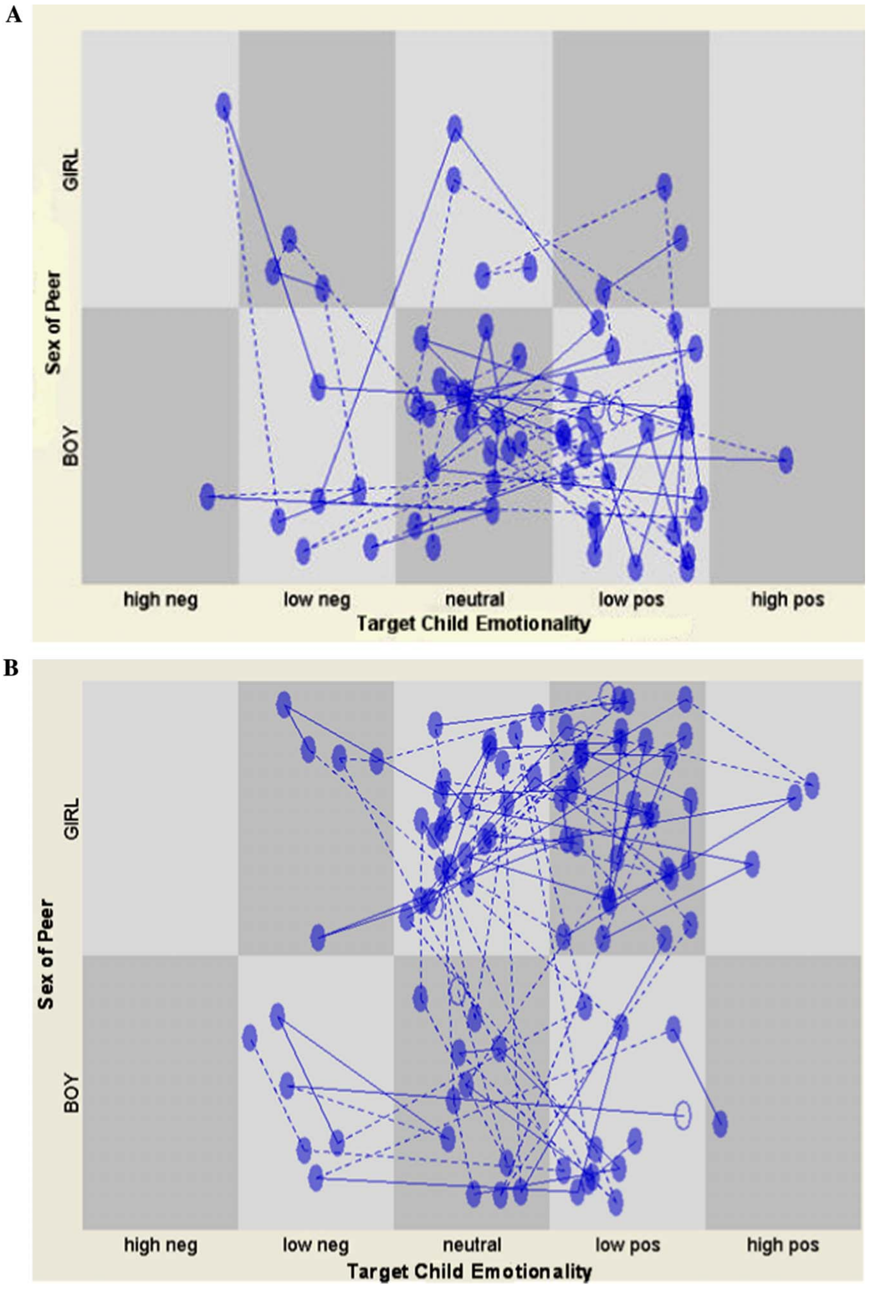

Fig. 5. Examples of SSG using focal observations. (A) Focal SSG for boys: Session 1 only. (B) Focal SSG for girls: Session 1 only.

of displayed emotions was greater when interacting with boys than with girls. Also, it was apparent that children experienced many more emotional displays while interacting with same-sex peers, and for both boys and girls, when interacting with same-sex peers, behavior tended to be drawn into neutral and low positive emotional displays; with other-sex peers, neutral displays were the most common. Thus, when interactions with all peers were considered, children's behavior tended to be drawn into regions representing neutral and positive emotions, and was not drawn into regions representing negative emotions.

Although it is not surprising that negative emotions tend to repel and positive emotions attract, a different type of comparison can be made to examine whether there are differential patterns of emotional displays depending on sex of peers. Whereas it appears that behavior was drawn into the region representing positive affect (low and high) with same-sex peers more than in the region representing positive affect with other-sex peers (boys, same-sex = 5.9, other-sex = 2.0; girls, same-sex = 6.0, other-sex = 1.9 mean events of positive affect), an accurate comparison across sex of peers requires consideration of base rate levels of interaction because children tended to interact with same-sex peers more often than with other-sex peers. To adjust for the number of interactions with same- and other-sex peers, the mean number of events was divided by the total number of events with same-sex and other-sex partners. A pattern of differential positive emotional displays was evident for girls although the differences were not as strong as before the base rate adjustment (.49 with same-sex peers vs. .37 with other-sex peers), and for boys, no differential display of positive emotion was evident (.42 with same-sex peers vs. .41 with other-sex peers). However, both girls and boys entered the positive affect region earlier when interacting with same-sex peers than with other-sex peers (for boys, same-sex = 18.4, other-sex 46.1; for girls, same-sex = 19.8, other-sex = 32.0). Return times to the regions were similar for boys (same-sex = 6.3, other-sex = 6.8), and differed for girls (same-sex = 6.2; other-sex = 9.3). Overall then, girls appeared to show more differential positive emotional responding to same-sex peers than did boys.

Interestingly, a sex difference also was apparent in displays of negative emotions. Although there were few expressions of negative affect with peers, when adjusted for the base rate of total events with each sex, girls experienced 4 times more negative affect events when interacting with peer boys (.31) than with girls (.07) (i.e., less with same-sex peers), but boys showed approximately equal expressions of negative emotions when interacting with boys (.09) as with girls (.10). Return times to return to regions of negative emotions for boys did not differ much for same-sex (8.0) and other-sex (7.5) interactions; for girls, return times to regions of negative emotions for other-sex interactions tended to be shorter than for same-sex interactions (same-sex = 8.0; other-sex = 6.7). For both sexes, first entry into the negative affect region with same-sex peers (boys = 35.8; girls = 41.8) occurred earlier than first entry into the negative affect region for other-sex peers (boys = 51.4; girls = 44.6). Girls more so than boys were drawn into displaying negative emotions when interacting with other-sex peers.

These findings suggest that girls in particular experience differential emotional displays depending on the sex of the peers with whom they interact. Girls were drawn into positive affective states when interacting with same-sex as compared to other-sex peers and they were drawn into negative affect states when interacting with other-sex peers. They may simply have more fun or feel more comfortable when they either share interests or think that they will share interests with a peer. This finding may not be surprising but it is interesting that boys did not show this differential pattern for positive emotional displays. Only girls showed differential responding with negative affect states when interacting with other-sex peers as compared to same-sex peers. Although boys did not show differential positive or negative emotional responding based on the sex of their peer partners, girls' responses suggest that they may be responding in a negative way to the rougher, agonistic, and dysregulated nature of boys' play styles.

Individual patterns of affective expression

When considering the reciprocal and recursive processes that help to shape the interactional landscape in preschool, it is helpful to examine the patterns of children who exhibit different long-term patterns. Specifically, children who over the course of several months interact much more with same-sex peers than with other-sex peers may have different attractors and repellors than children who show either more other-sex interactions or only moderately more same-sex to other-sex interactions. Using the focal observational data, four children were selected, two of whom showed much higher same- than other-sex play, and two of whom showed more balanced same- and other-sex play (few children showed higher other-sex play). Then, to examine their interactional patterns, SSGs were developed that represent the target's emotion on the X-axis and the recipients' emotion on the Y-axis.

The most striking difference between the two types of children was the spread of their affective behavior across the state space. As you can see in Fig. 6A, children who showed relatively higher levels of same-sex play over the term had restricted emotional displays compared to the children who engaged in more other-sex play (Fig. 6B). For same-sex playing children, emotionality appeared to be drawn into only a few regions of the grid (mainly positive and neutral regions); in contrast, for other-sex playing children, emotionality was more dispersed throughout the grid. Several SSG measures illustrate these differences. For same-sex playing children, the mean cell range (4.5) was smaller than for the other-sex playing children (8.9). Even in the first month of the semester, these differences were apparent. Closer inspection shows that over the first semester, both groups entered the region defined by neutral and positive emotions from both partners at about the same time (3.1 for same-sex playing children versus 2.3 for other-sex playing children), but same-sex playing children returned more quickly to this region (2.5 versus 4.4) and had proportionally more events within this region (95% versus 69%) than other-sex playing children. These patterns suggest that same-sex playing children and their interactional partners have a more tightly constrained affective repertoire than other-sex playing children with their partners, and that other-sex playing children may tolerate a wider range of emotions than same-sex playing children. For both types of children (and their partners), these patterns developed relatively early during the school term.

The findings on emotional patterns of children and their peers suggest that positive affective states tend to characterize the attractors involved in same-sex interactions whereas a broader range of affective displays tend to characterize other-sex interactions. Although it may not be surprising that children seem to have more fun with their own sex, such a finding raises questions about the role of affect and behavior on social organization. Do children seek out interactions with same-sex others because they expect to experience more positive affect with them or does the positive affect that they experience with same-sex others provide an impetus to seek out same-sex peers in the future, or do both processes influence sex segregation? To what extent do children use their own and other's affective states as cues about the nature of the interaction, and do they use affect and behavior matching to provide information concerning the future utility of continuing in these types of behavior?

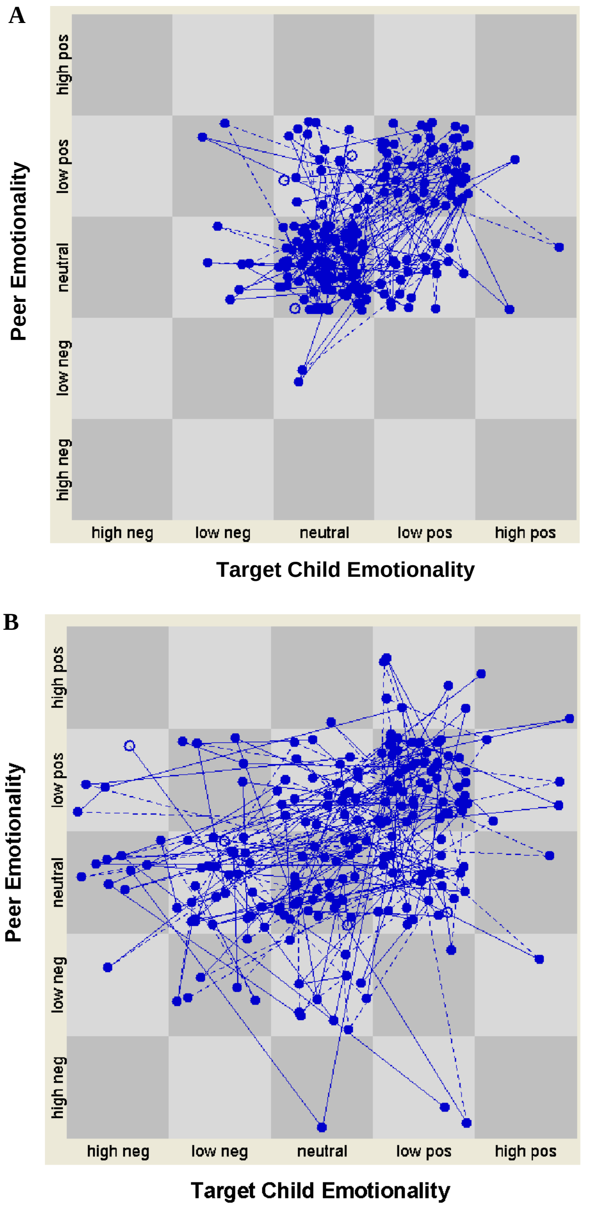

Fig. 6. Examples of SSG using focal observations. (A) Focal SSG for same-sex playing children. (B) Focal SSG for other-sex playing children.

Conclusions

As powerful and compelling a developmental phenomenon as sex segregation is, it does not involve complete sex segregation. Instead, there is fluidity in interactions, with children playing with same-sex children and then moving into play with other-sex children or to interacting with teachers or playing alone. Investigating both the stability and changes in the peer system provide insights into the forces that shape the landscape of children's behavior with peers. We agree with Thorne's statement that, "to understand the choreography of gender separation and integration among children (and among adults), we need to understand the dynamics of different social institutions and situations…. Explorations of *how* gender separation and integration take place, of ongoing process rather than presumed origins, can go a long way toward satisfying persistent curiosity about *why* gender separation exists" (Thorne, 1993, p. 61).

To help us understand the choreography of gender separation and integration, and more broadly, of how children's groups form and change, we borrowed concepts and methods from dynamic systems theory. Our goals were both methodological and theoretical. We reviewed and described a method—state space grid analysis—that has been successfully employed to study individual and dyadic patterns over time, and extended this to apply to the study of the broader social context of peer relationships. The DS method, and SSGs in particular, enabled us to analyze issues that were difficult or impossible to analyze using more traditional methods. Our goals were also theoretical in that we employed the DS approach to shed light on several important topics derived from the literature of young children's peer relationships. Although the data we presented were mainly for illustrative purposes, the findings suggest a number of interesting potential areas of future exploration concerning sex segregation and behavioral homophily. In particular, researchers may be interested in further investigating the early self-organization of preschool children's peer groups around sex of peers and behavior. The DS perspective provides new ways to think about old problems and new methods for handling complex social interactional data.

DS approaches provide additional insights into early peer processes in several ways. One, they provide access to new measures. In most extant studies of the organization of children's social contexts, the most commonly used metric involves children's affiliative preferences or contacts. For instance, in studies of sex segregation, researchers often assess the number or proportion of same-sex versus other-sex play partners using observational methods (e.g., Martin & Fabes, 2001) or, to assess social networks, researchers ask adolescents to describe who in a class hangs out together (Cairns, Cairns, Neckerman, Gest, & Gariepy, 1988; Cairns, Perrin, & Cairns, 1985). With SSGs, a number of measures are available that provide new insight into the processes that underlie the social organization of children's peer groups. For instance, measures of return time and first entry provide information about the context and timing of social behavior as compared to using single measures of affiliation.

The DS perspective encourages new ways of thinking about causality, which has also been useful in expanding conceptual views of peer processes. Whereas the traditional approaches more clearly separate concepts of peer selection and peer socialization, DS perspectives encourage a more holistic view in which selection and socialization become part of one larger picture of social organization. In this ongoing process, children exert some influence on the social system by their selection of peers. In turn, the peers exert influence through their acceptance or rejection of the child, their feedback and responses to the target child, and through their own preferences for other children. Thus, the social system provides differential spheres of socialization for children depending on their sex, their personalities, and their behaviors. Group-level and individual processes are strongly linked. Organization of the social system increases over time as individual forces coalesce into higher order processes.

Finally, the use of SSGs helps bring complex interactional data to life. Similar to many peer researchers, the standard method we have often employed involves aggregating large numbers of observations. In contrast, by using SSGs, we are able to view temporal patterns and observe how individual children and their interactional partners change over time. The ability to visualize data has been essential in changing our thinking about peer relationships in that it has spurred new hypotheses, research questions, and theoretical insights.

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