AFFILIATIVE STRUCTURES AND SOCIAL DEVELOPMENT

IN PRESCHOOL CHILDREN GROUPS

João Rodrigo Daniel

Tese submetida como requisito parcial para obtenção do grau de

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Palavras-chave:

estruturas afiliativas, relações entre pares, modelos p*, competência social

Key words:

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RESUMO

O grupo de pares é um dos principais contextos de desenvolvimento da criança durante a idade pré-escolar. Contudo, a maioria dos estudos sobre o desenvolvimento social da criança focam-se na procura de características individuais negligenciando os constrangimentos relacionais inerentes à ecologia do grupo de pares. A abordagem da etologia social, por contraponto, enfatiza a existência de diferentes nichos sociais que influenciam/constrangem o comportamento dos indivíduos, sugerindo que as diferenças individuais devem ser compreendidas à luz das relações diádicas e dos papéis sociais ocupados no interior do grupo de pares.

Os trabalhos empíricos aqui apresentados são uma tentativa para estabelecer uma ligação entre estas duas tradições de estudo das relações afiliativas em crianças de idade pré-escolar. Partindo de uma amostra de 247 crianças Portuguesas, provenientes de 19 salas de aula diferentes, algumas das quais observadas em dois ou três anos consecutivos, foram analisados num primeiro estudo os padrões colectivos de proximidade social. Através da análise hierárquica de clusters da semelhança dos perfis de associação diádicos, em cada uma das salas, foram identificados três tipos de subgrupos afiliativos: (a) subgrupos em que as crianças para além de apresentarem perfis de associação semelhantes partilham, ainda, uma *elevada proximidade mútua*; (b) subgrupos de crianças com perfis de associação semelhantes, mas que tendem a não passar muito tempo juntas (*baixa proximidade mútua*); e (c) crianças *não agrupadas*. Diferenças significativas no viés intra-grupo para medidas comportamentais e sociométricas indicam que os subgrupos identificados não são meros artefactos estatísticos e que os diferentes tipos de subgrupos (elevada proximidade mútua *vs.* baixa proximidade mútua) são funcionalmente distintos.

No segundo estudo, e recorrendo a desenvolvimentos recentes no campo da análise de redes sociais, analisaram-se os processos estruturais que estarão, potencialmente, na origem e desenvolvimento das estruturas afiliativas dos grupos de pares em crianças de idade pré-escolar. Os resultados deste estudo mostram que as relações afiliativas, nas 19 salas de aula, são altamente recíprocas, estabelecidas preferencialmente entre crianças do mesmo sexo e com a tendência para a criação de tríades transitivas. Estes resultados ajudam a compreender a existência dos subgrupos afiliativos identificados no primeiro estudo.

No último estudo investigou-se a relação entre os níveis individuais de competência social e o tipo de subgrupo a que as crianças pertencem. A competência social foi avaliada tendo por base sete indicadores diferentes agrupados em três famílias distintas – *motivação social e envolvimento*, *perfis de atributos comportamentais e psicológicos* e *aceitação de pares*. As crianças pertencentes aos subgrupos mais coesos (elevada proximidade mútua) foram as que apresentaram níveis mais altos de competência social, enquanto as crianças não agrupadas eram geralmente menos competentes que os seus pares. Estes resultados sugerem que a pertença a um subgrupo mais coeso, entre outros factores, pode contribuir para um desenvolvimento social mais ajustado.

Em suma, os trabalhos empíricos apresentados adoptam uma abordagem multi-método na tentativa de melhor compreender as estruturas afiliativas dos grupos de pares de crianças em idade pré-escolar, e o modo como estas estruturas se relacionam com o desenvolvimento da competência social.

ABSTRACT

The peer group is one of the main contexts for the development of preschool children. Nevertheless, most studies on child social development focus on individual characteristics neglecting the relational constraints inherent to peer group ecology. On the other hand, the social ethology approach emphasizes the existence of different social niches that influence/constrain individual behavior, stating that individual differences should be understood in the light of dyadic relationships and the social roles occupied within the peer group.

The empirical works here presented are an attempt to establish a bridge between both traditions in the study of preschool children affiliative relationships. With a sample of 247 Portuguese children from 19 different classrooms, some of which were observed in two or three consecutive years, the collective patterns of social proximity were analyzed in the first study. Through the hierarchical cluster analysis of dyadic association similarity profiles, in each classroom, three types of affiliative subgroups were identified: (a) subgroups in which children besides having similar association profiles also share *high mutual proximity*; (b) children' subgroups with similar association profiles but that do not tend to spend a lot of time together (*low mutual proximity*); and (c) *ungrouped* children. Significant differences found for in-group bias of behavioral and sociometric measures indicate that the identified subgroups are not mere statistical artifacts and that the different types of subgroups (high mutual proximity *vs.* low mutual proximity) are functional distinct.

In the second study, recent developments in the field of social network analysis were used to investigate potential structural processes in the origin and development of affiliative structures in preschool peer groups. The results of this study show that the affiliative relations in the 19 classrooms were highly reciprocal, sex segregated and with a tendency to create transitive triads. These results help to explain the existence of the affiliative subgroups identified in the first study.

In the last study the relation between individual levels of social competence and the type of affiliative subgroup to which children belong was assessed. Social competence was evaluated using seven different indicators, grouped into three distinct families – *social motivation and engagement*, *profiles of behavioral and psychological attributes* and *peer acceptance*. Children belonging to more cohesive subgroups (high mutual proximity) were the ones who presented higher levels of social competence, while ungrouped children were generally least competent than their peers. These results suggest that belonging to a more cohesive subgroup, among other factors, can contribute to a better social development.

In sum, the empirical works here presented adopt a multi-method approach in an attempt to better understand the affiliative structures of preschool peer groups, and the way these structures relate to social competence development.

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Chapter I

General Introduction

The term *ethology* refers to the *biological study of behavior* (Tinbergen, 1963) and its appearance as a modern discipline is associated with the work developed during the 1930s by Nikolaas Tinbergen, Konrad Lorenz and Karl von Frisch, joint winners of the 1973 Nobel Prize in Physiology or Medicine. Nevertheless its origins can be traced back to Darwin's (1872) *The Expression of the Emotions in Man and Animals*. Rooted in Darwin's theory of evolution (Darwin, 1859) earlier ethological studies brought a new approach to already existing problems (studied through the lens of disciplines such as psychology, physiology, ecology, sociology, taxonomy, and evolution), rather than the creation of new research questions (Hinde, 1982). These relations with other disciplines became one of the most important aspects of ethology (Hinde, 1982).

When in 1951 Tinbergen provided the first summary of ethological theory in *The Study of Instinct*, he tended to emphasize questions of proximal causality and behavioral development for documenting and explaining individual differences (Hinde, 1966). Only when *social ethology* branched from classical ethology, in the 1960's and 1970's, the emphasis was moved to the adaptive function of behavior and the evolution of behavioral structures (Crook, 1970a, 1970b; Kummer, 1971).

The rise of social ethology, as a distinct branch, occurred as the result of the accumulation of information about non-human primates' social behavior which influenced the conceptions of individual adaptation and social development. Crook's socio-ethological view highlighted that individual behavioral variation should be understood in terms of the dyadic relationships and the social roles within the social group because relying solely on global measures of individual activity neglected the fundamental importance of the transitory adjustments individuals experience when moving from one social setting to another. He saw social structure as a group characteristic, a dynamic system expressing the continuing interaction of multiple ecological and social processes, within a certain adaptive range for a given species, rather than a specific attribute of species.

Starting from Tinbergen's four *why* questions (causation, development/ontogeny, evolution/phylogeny and function/adaptation), Kummer (1971) framed the research program of social ethology by distinguishing five levels or dimensions of behavioral analysis: (a) *structural analysis* – a description of the organizational conditions of a living system, such as the anatomical underpinnings of a particular behavior pattern or the spatial arrangement of group members; (b) *causal analysis* – the underlying processes that lead to the appearance of the behavioral structures under study; (c) *functional analysis* – the emerging processes associated with the observed activities that increase the survival value of the living system; (d) *ontogeny* – the study of organic, social, and ecological processes that shape changes during the course of individual development; and (e) *evolution* – the long-term processes that determine survivorship and directly shape the genetic heritage on which ontogeny depends. Kummer's (1971) structural viewpoint reflected the emphasis on the constant dynamic transformation of living systems.

Although related to psychology from an early stage, Hinde (1982) considers the highlights of the relationship between ethology and psychology to be Bowlby's (1969) use of ethological concepts in his attachment theory, and the use of methods drawn from ethology to study young children's social behavior (Blurton-Jones, 1972; McGrew, 1972). Child social ethology extended theoretical and methodological notions from primatology at a time when observation procedures and behavioral measures in child psychology often lacked the methodological and conceptual rigor of animal ethology (Santos, 1993).

Even before the formal creation of social ethology, primatologists had already argued that group social organization involved both cohesive and dispersive mechanisms working together within the group. Nevertheless human social ethology studies, following the direction of research with non-human primates, focused their initial attention on social dominance (Omark, Strayer & Freedman, 1980; Strayer & Strayer, 1976), importing the concepts of dominance and hierarchy from animal studies, especially those on non-human primates.

Dyadic dominance describes the relative balance of social power between two members in a social group, while a dominance hierarchy is a higher-order structural principle that summarizes the organization of power relations among all group members. The assessment of social dominance was based upon determining *winner* and *loser* roles evident during episodes of social conflict. Most researchers initially accepted social dominance as a primary dimension of peer group social organization and only later a comparable interest in the function of cohesive behaviors emerged.

Traditional primatological view of social dominance stressed that primate social activities were influenced by dominance status differences between individuals (Chance, 1967; Chance & Jolly, 1970; Seyfarth, 1977), with dominant individuals being central group members. Like their non-human primate counterparts, dominant toddlers and preschoolers also play an important role in the peer group, being observed, imitated, and liked more by other children (Abramovitch & Grusec, 1978; Hawley & Little, 1999; LaFreniere &

Charlesworth, 1983; Pellegrini et al., 2007; Strayer & Trudel, 1984; Vaughn & Waters, 1980, 1981).

Nevertheless, Vaughn and Waters (1981) soon questioned the social ethology assumption about the role of dominance as a central organizational principle in early peer groups, and argued instead that it was social competence and not social power that attracted peers.

These first criticisms lead years later to the substitution of the view of dominance as an agonistic strategy leading to submission for a view that allowed the use of both prosocial and coercive tactics to gain and maintain control over classroom resources (Charlesworth, 1988; Hawley, 1999). This new conceptualization tried to account for, not only, findings that showed that high rates of initiating aggression did not necessarily translate into increased utilization of resources (LaFreniere, 1996; LaFreniere & Charlesworth, 1987), but also for non-ethological literature showing that aggressive behavior can lead to maladaptation in the short and long term, as well as peer rejection (Coie & Dodge, 1983; Dodge, Coie, Pettit & Price, 1990; Newcomb, Bukowski & Pattee, 1993; Pettit, Bakshi, Dodge & Coie, 1990). At the core of this change is the idea that if social dominance is adaptive in terms of evolutionary sense, then it should not be associated with behavior that is maladaptive in the psychological sense (Hawley, 2002).

Connecting prosocial and coercive behavior in the service of competition considers both types of behavior as pathways to resource control. This link, however, is not consensual given that affiliation and dominance may have distinct motivational systems, with different evolutionary and ontogenetic histories, rather than being alternative pathways to resource control (Strayer, 1989). This view of dominance also reduces socio-contextual processes to a psychometric calculus of individual differences (Strayer, 1980a) neglecting emergent aspects of group dynamics (Santos & Winegar, 1999). Some critical challenges were also raised by this approach. While dominance hierarchies reflect asymmetries between group members and can be reduced to rank orders, affiliation networks cannot be reduced to a rational rank order (Vaughn & Santos, 2009). This means that while dominant children can be described in terms of individual descriptors that correlate with dominance rank (Hawley, 2002; Vaughn & Santos, 2009), affiliative networks can only be described using group-level descriptors (Vaughn & Santos, 2009). But even reducing dominance structures to a rank order entails the loss of information about *who does what to whom* (Vaughn & Santos, 2009).

Clarifying the processes underlying the coordination of dispersive and cohesive activities in children's play groups served as stimulus to deepen the research on the development of affiliative structures. Representing these structures was the problem that Strayer (1980a, 1980b) tried to tackle when he introduced behavioral sociometry to child ethology, adapting sociometric procedures from sociology (Moreno, 1934). The study of the affiliation had been delayed at that point by a lack of adequate structural models for representing cohesive structures (Santos, 1993).

Strayer's behavioral sociograms summarized preschool groups' affiliation structures by depicting affiliative links between pairs of group members. These links or behavioral preferences were determined by comparing the relative frequency of initiated affiliative acts to a fixed value (e.g., average initiated acts directed to all classmates). The sociograms provided a visual representation that seemed to indicate that individuals were organized in distinct affilitative subgroups and that the hierarchical models used to represent dominance structures could not be used to represent affiliative structures, because cohesive social structures lacked the asymmetric and transitive social roles characteristic of dominance hierarchies (Santos, 1993).

Even though Strayer's behavioral sociograms provided some insights into group organization, the information they contained proved analytically difficult and did not allow easy quantitative comparisons within or across groups (Vaughn & Santos, 2009). It was only with the introduction of multivariate analytical techniques, borrowed and adapted from the study of school-age children's social networks (Cairns, Cairns, Neckermann, Gest & Gariépy, 1988; Cairns, Perrins & Cairns, 1985) that the characterization of affiliative structures of preschool children gained a considerable boost.

Relying on direct observations of naturally occurring affiliative behavior in preschool classrooms Santos, Strayer, and associates (Santos, 1990, 1993; Santos, Vaughn & Bonnet, 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008; Strayer & Santos, 1996) showed that the use of hierarchical cluster procedures, focusing upon similarity of dyadic association profiles, was a valuable tool for the structural analysis of affiliative structure in preschool peer groups. Their findings indicated that the vast majority of children were members of cohesive subgroups. Later, density-based measures of selective association were employed to provide complementary information on subgroup cohesion. The fact that two children could associate with the same peers (and have a similar association profile) but not necessarily associate with each other lead Santos et al. (2000) to refine the analysis and define two types of subgroup categories. One refering to subgroups of children with similar profiles of proximity and significant proximity to each other (*high mutual proximity* – HMP) and another refering to subgroups of children who do not show significant proximity to each other (*low mutual proximity* – LMP). Children who were not members of either subgroup type constituted a third social category, referred to as *ungrouped*.

More recently Santos, Vaughn and Bost (2008) provided one of the rare attempts to bridge the two conceptual and methodological traditions within developmental science of peer relationships: child and clinical psychology *vs.* socio-ethological and sociological traditions. The first focused on the individual child and the effects her or his behavioral character, experiential attributes, and/or relationships may have on her or his own development or on the behavior and opinions of others. The second, focused on the structural features of children's groups, on the processes underlying structure and/or the affordances and constraints on behavior and character development of such group structures. To accomplish this, Santos et al. (2008) stratified subgroups according to the sociometric acceptance level and analyzed the relations between subgroups sociometric level and the degree of in- *vs.* out-of-subgroup bias of behavioral and sociometric measures.

In a general sense, the core idea underlying the three empirical studies presented in this thesis (and most all other studies referred above) is that the peer group acts has an important context for development in preschool years. The first study extends Santos, Vaughn and Bost (2008) report from a sample of African-American children to a Portuguese sample, using a different statistical approach that allowed testing the influence of subgroup sociometric level on subgroup bias together with the influence of other important variables such as age and subgroup sex composition.

The hierarchical clusters procedures used by Strayer, Santos and associates have proven to be a valuable tool for describing preschoolers' cohesive structures. These procedures can now be complemented with recent developments in social network analysis that permit the elaboration of statistical models that go considerably further than just describing this structures. In the second study, the framework of exponential random graph models (Robins & Pattison, 2005; Robins, Pattison, Kalish & Lusher, 2007; Snijders, Pattison, Robins, Handock & 2006; Wasserman & Robins, 2005) was used to study how the influence of different social processes (reciprocity, transitivity, popularity and sex homophily) might work together on the creation of affiliative structures.

Finally, the third empirical investigation represents a new attempt to bridge social ethology and child psychology traditions in the study of preschool children's social development. The main purpose was to assess the extent to which the different levels of cohesion in the social units to which children belong (identified with the hierarchical cluster techniques of Strayer and Santos) relate to individual levels of social competence.

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Chapter II

Affiliative Subgroup Bias in Preschool Peer Groups

Abstract

Ethological studies of preschool group structure highlight concepts of social niches and potential roles associated with occupation of specific niches that offer novel perspectives on behavioral constraints at the individual level. Nineteen Portuguese preschool peer groups (N = 463) were observed to determine physical proximity, visual attention and social interaction to peers, by means of focal sampling. All children completed three picture sociometric tasks. Similarity of association profiles was analyzed for each classroom using a complete linkage hierarchical clustering algorithm. Three subgroup types, *high mutual proximity* (HMP), *low mutual proximity* (LMP), and *ungrouped* children were identified. Significant in-group bias differences were observed for HMP and LMP subgroups using behavioral and friendship measures of social attention and sociometric acceptance data. In-group preferences were more marked for HMP subgroups indicating that the two subgroup types are functionally distinct. Results are consistent with previous ethological studies of affiliative structures in preschool classrooms.

Key words: affiliative subgroups, in-group bias, peer relations

Introduction

The study of peer interactions and friendships has demonstrated the weight of the peer group as a context for development across a wide range of ages. Within such peer group relations, friendship relationships are particularly thought to influence several domains of child social adjustment and personal development (Asher, Parker & Walker, 1996; Asher & Renshaw, 1981; Howes, 1983, 1987, 1988; Ladd, 1990; Ladd, Kochenderfer & Coleman, 1996; Newcomb & Bagwell, 1995; Parker & Asher, 1987, 1993; Youniss, 1980; Youniss & Smollar, 1985). Since Cairns' (1983) seminal review on the distinction between sociometric and psychometric approaches there was a resurgence of interest in the analysis of how affiliative structures in natural peer groups differentially afford or constrain individual early social development. Procedures and multivariate analysis, based either upon structured socio-cognitive interviews (Cairns, Perrin & Cairns, 1985) or upon direct observation of naturally occurring behavior (Strayer, 1980a), have been elaborated for identifying affiliative networks within stable peer groups.

Children's groups from early childhood through adolescence can be partitioned into subgroups that share common attributes, although these may vary across subgroups and age levels. Overall, such sociological and socio-ethological oriented research on peer relations claims that membership in particular cliques, social clusters or subgroups both directs and constrains the individual's contemporaneous and future social behavior (Bagwell, Coie, Terry & Lochman, 2000; Cairns et al., 1985; Cairns, Cairns & Neckerman, 1989; Cairns, Cairns, Neckermann, Gest & Gariépy, 1988; Gest, Farmer, Cairns & Xie, 2003; Gest, Graham-Bermann & Hartup, 2001; Hallinan, 1981; Hallinan & Smith, 1989; Santos, 1990, 1993; Santos, Vaughn & Bonnet, 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008; Santos & Winegar, 1999; Strayer, 1980b, 1989; Strayer & Santos, 1996).

Nevertheless, most developmental studies of preschool children were initiated from the child and clinical research traditions and thus less attention was given to the structural features and processes occurring in stable groups than to the social exchanges taking place within these structures. Within these traditions, the principal focus is the individual child and the effects that her or his behavior or relationships with others may have on her or his own development or on the behavior and perceptions of peers. A similar trend was present in classical ethology (Hinde, 1966) that was centered upon questions of proximal causality and behavioral development for documenting and explaining individual differences. In contrast, the emergence of social ethology as a second branch of behavioral biology involved a shift of interest towards questions about the structure and adaptive function of social behavior (Crook, 1970a, 1970b; Kummer, 1971). Because it focuses on the organization and functioning of groups, social ethology appears more directly related to the fields of social psychology and sociology. Current ethological studies of preschool group structures highlight concepts of social niches and potential roles associated with occupation of specific niches and the way that they offer novel perspectives on behavioral constraints at the individual level (Vaughn & Santos, 2009).

The present study examines the relations between an observation-based procedure for identifying preschool affiliative subgroups and both peer interactions and peer verbal nominations. An underlying assumption of this approach is that individual and group based complementary methods of inquiry are necessary for a better understanding of the complexity of relationships within a natural social group. Thus, the primary goal of the study is to integrate the respective contribution of each method in characterizing the affiliative organization in children's play groups, rather than to endorse a particular approach.

The notion that members of a social unit maintain close proximity and develop a semi-closed system of positive communication has a central and long history in the study of primate social ethology (see Kummer, 1971). From classical sociograms (Moreno, 1934) to the far more elaborated subsequent development of social network analysis, such representations of cohesive social structure have been used to describe and discuss the evolution of primate social systems. Most frequently, the algorithms to define a social unit or cohesive subgroup in social network analysis allow subgroup boundaries to overlap, however, such overlapping clusters fail to identify clear inside and outside boundaries that are necessary for understanding positive and negative social preferences and interactions both within and between subgroups. In this sense, the identification of non-human primate and child affiliative structures privileges non-overlapping subgroup identification techniques.

For example, Strayer and Santos (1996) examined affiliative behavior matrices of children in 15 preschool classrooms who had been observed over a period of several weeks using hierarchical cluster analyses. Distinct subgroups of children were observed in every classroom and the mean subgroup size and the degree of reciprocity or mutuality of affiliative exchanges tended to increase with age. Furthermore, the proportion of children identified as members of cohesive subgroups increased from about 50% for the youngest children (between 12 and 24 months) to over 90% for the oldest children (60+ months).

Later, Santos et al. (2000) used nearest neighbor observations and the same clustering procedures for describing the affiliation structure for a single classroom of 4-5 year old children as it evolved over the academic year. They reported that, for the most part, the subgroup structure remained intact across the three waves of data collection even though some group members left the class during the year. Also, children who were ungrouped at the beginning of the year tended to become group members in subsequent waves of data collection. These studies also reported the existence of different subgroup categories, namely children with similar profiles of proximity vis-à-vis other classmates who either showed, or not, significant proximity to each other. These two subgroup types were referred as *high mutual proximity* (HMP) and *lower mutual proximity* (LMP) subgroups, respectively.

Another common aspect of the study of primate social ethology involves assessing the degree of group social stratification (Crook, 1970a). Any discussion of social status within the group requires specifying operational measures for distinguishing the relative position of individuals and subgroups within the social structure, a concern that is also common among many researchers in social sciences since Moreno's (1934) early concept of *sociometric star*.

Primate field researchers, for example, sought to measure social status by determining functionally equivalent classes of social activity that provide a reliable basis for ranking group members in terms of relative social influence or relative success in agonistic encounters (Altmann, 1962; Richards, 1974). Similar indices have been proposed to assess the degree of social stratification for social power relations in children's peer groups (Barner-Berry, 1980; Savin-Williams, 1979). Other uses of social stratification in child social ethology are found regarding individual differences in affiliative activity, social attention and social control (Abramovitch, 1976; Hold, 1976; Strayer, 1980b, 1989).

Measures of status differentials – conceptualized in terms of popularity (Hartup, 1970, 1983; Hartup, Glazer & Charlesworth, 1967), general likability (Asher, Singleton, Tinsley & Hymel, 1979), social impact (Peery, 1979), sociometric classification (Asher & Dodge, 1986; Coie & Dodge, 1983, 1988) and relative centrality of individuals and social subgroups (Cairns et al., 1985; Cairns et al., 1988; Gest et al., 2001) – have also been cornerstones in developmental research on peer group relations and social adjustment. Traditional primatological view of social dominance has also stressed that primate social behavior is influenced by dominance status between individuals (Chance, 1967; Chance & Jolly, 1970; Seyfarth, 1977). Demonstrating that preschool children differentially allocate their social behavior and friendship choices towards group co-members as a function of their subgroup status provides more evidence for early structural constraints.

When Santos et al. (2000) stratified their subgroups according to the average of their members sociometric acceptance (*high*, *medium*, or *low* levels of acceptance using data from all class peers), within-subgroup bias at the behavioral (i.e., proportion of social attention directed to co-members) and sociometric (i.e., choosing preferred peers within the subgroup) levels were significantly greater for high status subgroups.

Santos, Vaughn and Bost (2008) used the same nearest neighbor observations and clustering procedures in a sample of 30 classrooms. Independent chi-square analyses revealed that members of both HMP and LMP subgroups chose co-members as positive attention targets rather than the other classmates at a greater level than chance. A similar but inverse pattern was obtained when the analyses were conducted for negative social attention preferences (i.e., classmates who were targets of attention at significantly less than chance levels). Additional analyses for positive and negative social attention preferences, directly comparing the two types of subgroups, showed they were greater for the HMP than LMP subgroups. After stratifying both subgroup types in terms of sociometric acceptance and repeating the analyses, only children in low acceptance status, LMP subgroups failed to show positive attention preference for co-members. Tests for negative attention preferences revealed an inverse pattern and were also significant at all levels of acceptance status for the HMP subgroup. This negative attention out-group bias was seen also for the high acceptance status, LMP subgroups, but not at medium or lower levels of acceptance. Further comparison of the two subgroup types at each level of acceptance status indicated that in-group preferences were stronger in HMP subgroups at all levels of acceptance status. When the friendship choices were examined, however, only the HMP subgroups showed a significant preference for their own subgroup members. A subsequent test comparing directly the inside and outside choices for the two subgroups types supported this conclusion. Further stratifying the subgroups indicated that friendship preference for co-members was only marked for high status HMP subgroups.

Taken together, the results of these studies indicate that classes of preschool children can be subdivided into reliably coherent subgroups that differentially exchange affiliative behaviors, social attention, and friendship preferences. Moreover, the degree to which these exchanges occur is nuanced according to subgroup type and to the social acceptance status level of the subgroup.

In the present study, we assessed affiliative subgroup bias aligned with the ethological and developmental traditions. The proliferation of chi-square analyses that we described (Santos et al., 2008) just considering bias distinctions between stratified subgroup types was avoided. Such approach would prevent us from studying the possible influences of other relevant factors influencing subgroup bias. Besides the obvious extension of previous results from American samples to a Portuguese sample, we further tested the influence of age and subgroup sex composition on subgroup bias, using a multilevel model.

Method

Participants

The overall sample consisted of 247 different children, 116 of them being followed in two or three consecutive years (N = 463). Participants were recruited from 19 classrooms in two different centers serving middle class families in the region near Lisbon, Portugal. Classrooms ranged in size from 20 to 27 children. A total of 145 *3-year-olds* (i.e., children < 48 months of age at the start of the academic year, 70 girls, 75 boys), 145 *4-year-olds* (i.e., children between 48 and 60 months of age at the start of the academic year, 73 girls, 72 boys) and 173 *5-year-olds* (i.e., children between 60 and 72 months of age at the start of the academic year, 89 girls, 84 boys) were observed and interviewed.

Assessments

Teams of research assistants independently collected the observation and interview data. Children absent from the classroom for 50% or more of the observational rounds in any classroom were not given rate scores (i.e., treated as missing for these observations).

Observations. Using a focal individual sampling design, children were observed for a 15-s interval. At the end of the sampling interval, the child's nearest peer neighbor was identified. A peer who was within an arm's reach (roughly 3-4 feet) and engaged in the same or a similar activity as the target child was considered the nearest neighbor of the target. If two or more children were equally close to the focal child (as often happened when children were engaged in table activities or in group time) the peer to the child's immediate right was considered as nearest neighbor. For instances in which a child was interacting verbally or physically with a peer at the end of the 15-s interval, the interacting partner was considered as the nearest neighbor, even though another child might be physically closer. This was most frequent for table activities during which the target might have had a conversation with a peer across the table, rather than with the child immediately adjacent.

Observers collecting nearest neighbor information also collected interactions and visual attention data. An observer watched a given child for a 15-s interval and recorded identifiers for all children with whom the target engaged in interaction. Codes for the initiator, receiver and affective valence (*positive*, *neutral*, or *negative*) of the interaction episode were recorded. Interactions were coded as positive if one or both children showed positive affect in the context of the social exchange (i.e., smiling, laughing, gesturing, or vocalization indicating a positive feeling), and no expressions of negative affect (e.g., crying, distress, pain, strong irritability) were displayed by the interactive partner. Interactions were coded as negative if one or both children expressed negative affects (e.g., anger, distress, fear, sadness) in a facial, vocal, or gestural mode, unless these expressions were made in the context of fantasy play. All exchanges not identified as positive or negative were coded as neutral (e.g., exchanges of greetings or conversations during a meal or in the context of a school-related task that did not include the expression of affect, non-verbal exchanges that included physical contact and a reaction to contact).

Additionally, observers watched a given target child for a period of 6 s and recorded the identity codes for all children receiving a unit of visual regard from the observation target (no child was credited with receiving more than one unit of visual regard per 6-s. interval although several different children could each receive one unit from a given target in a single interval).

No child present in a classroom was observed twice before all other peers were observed once. Children were randomly observed. Rounds of the three types of observational data were interspersed. Two observers collected 200 observation rounds in each classroom for each type of observational data. Observers did not work in pairs and rarely observed a given child simultaneously. The numbers of observation rounds completed by different observers were approximately equal within a given classroom. In each classroom, observers spent approximately 60 min on the first observation day to become familiar with the names of participating children.

Research assistants received training in the observation schedule prior to initiating classroom observations. Observations took around three weeks to complete. Rater agreement was estimated as the alpha coefficient for individual rate scores across raters. That is, the vector of rate scores from the observations of one observer was treated as a single "item" and the standard internal consistency estimate (Cronbach's alpha) was calculated. This estimate assesses the representativeness of scores contributed by individual observers, rather than agreement per se for the targets of one child's behavior. Mean (± *SD*) reliability estimates were .86 (± .10) for nearest neighbor, .82 (± .14) for social attention, .76 (± .12) for neutral interactions and .63 (± .20) for positive interactions.

Sociometric measures. All children completed three picture sociometric tasks: (a) *positive and negative nominations*; (b) *paired comparisons*; and (c) *rating scale*. In each task, judgments were solicited about all classmates (both boys and girls). The assessments took place outside of the classroom in a quiet area. Typically, the nominations task was administered first, followed by the rating-scale task. The paired comparison measure was always administered last. Sociometric interviews took between 30 and 45 min to complete (usually two or three 15-min sessions). If a child's attention appeared to wander, the interviewer stopped the task and continued the interview at another time.

For the nominations task, children were presented with the array of photographs of all classmates and asked to name each one. After successfully naming all classmates, the child was asked to identify a peer that she or he *especially liked.* The request was repeated two more times and then the child was asked to identify a peer she or he *did not especially like* (again repeated twice). After making three positive and three negative nominations, the child was asked to return to the array and identify additional children she or he liked. These were turned face down as nominated until the child had made a choice for each class member in the array. In this task, every classmate received a score indicating the order in which she or he was chosen. For the rating-scale task, the child was presented with photographs of classmates in a random order and asked to indicate how much the peer was liked by placing the photo into one of the three buckets. The child was also asked to verbalize his choice. The target child was assigned a score of 3 if he or she was *liked a lot* and a score of 1 if she or he was *not liked very much.* For the paired comparisons task all possible pairs (total number of comparisons in a given class = $N(N - 1) / 2$ were shown to the child being interviewed. The child was asked *which of these two children do you especially like?*, for each pair. The ordering of pairs was such that all children in a given group were seen once before any child was seen twice and each child's photograph appeared an equal number of times on the left and right hand sections of the stimulus cards.

Data analysis

Affiliative subgroups. The first step in our analyses involved tabulating nearest neighbor observations for each child in a classroom. Children were assigned rows in a dyadic matrix and observed frequencies of proximity with each peer as nearest neighbor were tabulated into columns. This produced an asymmetrical dyadic matrix (where asymmetry implies that the AB cell in the matrix may not be equal to the BA cell). At the next step, the matrix was rotated on its major diagonal and added to itself, resulting in a symmetric dyadic co-occurrence matrix (i.e., AB = BA). The symmetric co-occurrence matrix was used to examine similarity of proximity profiles for each classroom using the complete linkage hierarchical clustering algorithm. Pearson correlations provided frequency independent measures of similarity of association.

Hierarchical cluster analysis is a set of techniques for identifying groups of similar objects (or persons) from larger sets of objects when the number of groups is not known a priori. The complete linkage (also called furthest neighbor) algorithm separates clusters on the basis of the largest distance between any pair of objects within clusters. Numerical taxonomists (Legendre & Legendre, 1983; Sneath & Sokal, 1962) have suggested that this algorithm is useful for taxonomy problems because it tends to form tight, spherical clusters of objects/persons. The algorithm suits our needs to identify children with similar profiles of proximity to other classmates but it may over-identify such groups and (as is the case for all clustering methods) the fact that cases can be grouped together does not necessarily prove that those sub-groups (i.e., clusters) have meaning.

To provide a check on the integrity of the clusters, we first chose an arbitrary level of within-cluster similarity (i.e., within-cluster correlation coefficient at the conventional level of significance, $p < .05$) to identify subgroups *vs.* ungrouped cases. Figure 1 displays a representative cluster dendogram. The vertical line crossing each dendrogram indicates the point at which the within-cluster similarity correlation has a value with $p < .05$.

Second, to identify high *vs.* low mutual proximity subgroups, the subgroups were split up according to the level of mutual proximity among group co-members. If the probability of proximity frequencies among members was < .001 in a χ^2 test, a subgroup was considered to show high mutual proximity. If the probability of proximity frequencies was ≥ .001 for any subgroup member in these tests, the subgroup was considered to be low in mutual proximity.

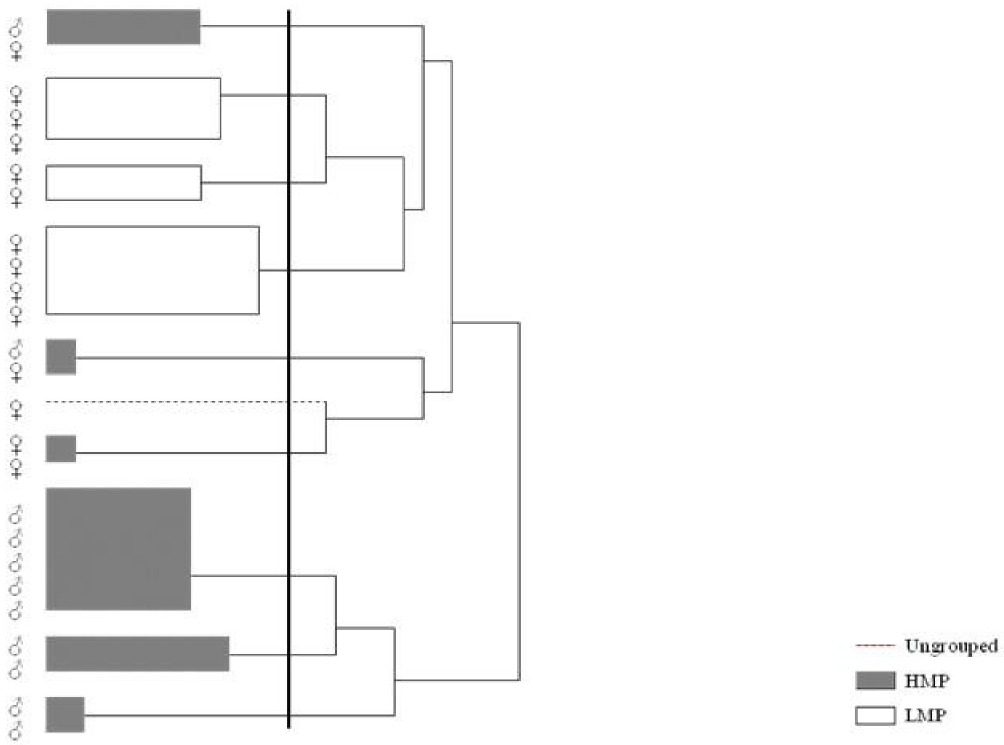

Figure 1

Dendogram of a Peer Group

Note. High mutual proximity (HMP) subgroups are identified in the dendrogram as dark rectangles and low mutual proximity (LMP) subgroups as white rectangles. Ungrouped children are represented as single lines in the dendrogram.

Subgroups were also characterized according to sex composition (*all girls, all boys* or *mixed*) and sociometric acceptance status (*high*, *medium*, or *low*). Within classroom total acceptance scores from the paired comparisons sociometric task for each subgroup were aggregated and averaged. The peer acceptance score of each child was calculated as the total number of choices received from peers, in the paired comparisons task, divided by the number of classmates completing the task. These scores were converted to percentile ranks (PR) for each class and subgroups were categorized as having low (PR < 30), medium (30 < PR < 70), or high (PR > 70) acceptance status.

Friendship Choices. Following Vaughn et al. (2000), sociometric data were used to identify friendship dyads. To be considered as a *friend* a peer had to appear among the upper quintile on either the nominations or the paired comparisons sociometric tasks and had to receive a rating of 3 on the rating scale task.

Sociometric status. Nominations sociometric data were used to derive status category classifications (following the procedures described by Asher & Dodge, 1986) for *popular*, *neglected*, and *rejected* children (all others were classed as *average*). Subgroups were *pure* if all members of the subgroup had the same sociometric status, *mixed-P* if at least one child in the subgroup was classified as *popular* and *mixed not-P* if no child in the subgroup was classified as popular.

In-group bias. For each member of a multi-child subgroup, the mean proportion of social attention, positive and neutral interactions, and friendships choices given to group members were used as measures of in-group bias. Because the outcome variables are proportions we used generalized linear mixed models (with a logit link and a binomial error distribution) to understand which variables affect in-group bias. These variables were related to children' age and subgroup characteristics (type of subgroup, sex composition, status and subgroup size).

Given that some of the children had repeated measures, two level-models were created with the repeated measures at the lowest level and the individual children at the highest level. Multilevel modeling does not require the same number of measurements for all individuals in order to obtain efficient estimates (Hox, 2002). This procedure allowed us to use the full sample (N = 463). In some longitudinal studies it is common to encounter small numbers of observations for each individual (*large J, small N designs*), but despite this, multilevel models are still very effective in detecting fixed effects of model predictors (de Leeuw & Meijer, 2008).

Results

Aggregating across the 19 classrooms, a total of 145 multi-child subgroups were identified and 37 children were ungrouped. 109 subgroups were classified as HMP (75.17 %), and 36 were classified as LMP (24.83 %). High mutual proximity subgroups were observed in every classroom, LMP subgroups were found in 14 of 19 classrooms and ungrouped children were present in 16 classrooms. No classroom contained subgroups of only one type. Approximately 74 % of identified multi-child subgroups were of the same sex (107 / 145).

Table 1

Number of Boys and Girls Present in Each Affiliative Subgroup

Affiliative roles	**Girls** (n = 229)	**Boys** (n = 226)	**Total** (N = 455)
HMP (n = 325)	153	172	325
LMP (n = 93)	53	40	93
Ungrouped (n = 37)	23	14	37

Table 1 shows the distribution of boys and girls according to subgroup type. Boys and girls were equally represented in each subgroup type, although a non-significant trend was found, N = 455, $\chi^2(2) = 5.10$, p = .08. Boys were slightly more likely to be present in HMP subgroups, while girls were somewhat more common in LMP subgroups and as ungrouped children.

Cross-tabulation analyses further indicated that the proportion of children belonging to each subgroup type varied as a function of age, N = 455, $\chi^2(4) = 11.58$, p = .02 (Table 2). Children in HMP subgroups were more common among 5-year-olds. Subgroup sex composition, N = 145, $\chi^2(2) = 1.21$, p = .55, and subgroup stratification, N = 145, $\chi^2(2) = 2.14$, p = .34, were independent of subgroup type.

The cross-tabulation of subgroup type by sociometric status is presented in Table 3. Around 73 % of the subgroups included children with different sociometric status. None of HMP or LMP subgroups were made of exclusively popular or rejected children. Almost all (37 / 39) of the pure status subgroups were of average children.

Subgroup size ranged from 2 to 6 across classrooms. Approximately 43 % (Total = 62 / 145, HMP = 44 / 109, LMP = 18 / 36) of the multi-child subgroups were dyads and these dyads accounted for near 30 % of grouped children. Only 10 HMP subgroups had more than four children and only one HMP subgroup was composed of six children. ANOVA on subgroup size using age, subgroup type, sex composition of subgroup and subgroup stratification as independent factors, revealed a near-significant trend for subgroup type, $F(1, 135) = 2.90$, p = .09 ($M \pm SD$: HMP = 2.96 ± 1.00, LMP = 2.58 ± .65).

Table 2

Affiliative Subgroups by Age Class

	Subgroup type		
	HMP	**LMP**	**Ungrouped**
Age	(n = 325)	(n = 93)	(n = 37)
3 (n = 142)	91	39	12
4 (n = 143)	98	31	14
5 (n = 170)	136	23	11

Table 3

Cross-tabulation of Subgroup Type and Subgroup Sociometric Status Classifications

Subgroup type	**Mixed P**	**Mixed non-P**	**Popular**	**Average**	**Neglected**	**Rejected**
HMP	31	45	0	33	0	0
LMP	12	16	0	4	2	0

Note. Subgroups were classified has mixed-P if at least one child in the subgroup was popular and mixed not-P if no child in the subgroup was popular. Remaining categories include children with the same sociometric status. Individual sociometric status: 282 average, 52 popular, 54 rejected, 56 neglected.

Table 4 summarizes parameter estimates for the multilevel models of the in-group bias variables. Subgroup type (HMP or LMP) had a significant effect on all dependent variables studied (i.e., in-group proportions).

High mutual proximity subgroup members tend to direct more positive social attention, more neutral and positive interactions, and more sociometric friendship choices to their co-members than children in LMP subgroups (Table 5).

Subgroup status only had a significant effect for friendship choices (a trend was also found for social attention). In-group bias for friendship sociometric choices decreased with subgroup status (high *vs.* medium *vs.* low status model estimate means ± *SE*: .20 ± .03, .16 ± .02, .12 ± .02; pairwise comparisons – high *vs.* medium: p = .13; high *vs.* low: p < .01; medium *vs.* low: p = .03).

Table 4

In-group Bias Multilevel Models

	F statistic			
Model	**Social attention** (*df2* = 330)	**Neutral interactions** (*df2* = 244)	**Positive interactions** (*df2* = 281)	**Friendship choices** (*df2* = 319)
Subgroup type (*df1* = 1)	288.56**	240.89**	97.00**	16.46**
Subgroup stratification (*df1* = 2)	2.79+	.03	2.53	5.12**
Age (*df1* = 2)	25.87**	33.05**	34.19**	.07
Subgroup sex (*df1* = 2)	3.93*	9.10**	1.42	.52
Subgroup size (*df1* = 1)	361.23**	133.75**	229.77**	53.76**

Note. $^{+}$ p < .10, * p < .05, ** p < .01.

Age also influenced in-group bias for observational measures (3- *vs.* 4- *vs.* 5-year-olds model estimate means ± *SE* – social attention: .20 ± .01 *vs.* .15 ± .01 *vs.* .16 ± .01; neutral interactions: .25 ± .02 *vs.* .15 ± .01 *vs.* .17 ± .01; positive interactions: .33 ± .04 *vs.* .14 ± .02 *vs.* .14 ± .02). Pairwise comparisons distinguished 3-year-olds from the two other age class groups in all the three in-group bias variables (p < .01).

Subgroup sex composition had a significant influence on the distribution of social attention and neutral interactions (mixed *vs.* girls *vs.* boys model estimate means ± *SE* – social attention: .15 ± .01, .18 ± .01, .16 ± .01; neutral interactions: .15 ± .01, .20 ± .02, .21 ± .02). Pairwise comparisons distinguished mixed subgroups from sex segregate subgroups (p < .01) for both variables and girls subgroups from boys subgroups for social attention (p = .04).

Table 5

Estimated Means of In-Group Bias According to Subgroup Type

Subgroup type	**Social attention**	**Neutral interactions**	**Positive interactions**	**Friendship choices**
HMP	.27 (.01)	.35 (.02)	.39 (.02)	.23 (.02)
LMP	.10 (.01)	.09 (.01)	.08 (.02)	.10 (.02)

Note. Standard errors are in parentheses.

Discussion

The need to simultaneously consider the developmental, and the sociological/ethological approaches in the study of preschool peer groups' affiliative structures was stressed in the first part of the introduction. The results obtained in this study consolidate that rare bridge between the two traditions, by extending previous findings of Santos, Strayer and associates. Also, because Portuguese samples are underrepresented in research with young children from any tradition in social development, our study is a major contribution in the characterization of this population. Two specific issues were chosen to guide the present research: (a) identification and stratification of preschool affiliative structures; and (b) analyzing affiliative subgroup bias. Globally, the results found suggest that the clustering approach to preschool classroom social structures used by Strayer, Santos and associates is a useful procedure.

Concerning the first issue, the three subgroup types (HMP, LMP and ungrouped children) were identified in the vast majority of classes. At least two subgroup types were present in every classroom. Both sexes were approximately equally represented in each of the subgroup types (boys were slightly more likely to be present in HMP subgroups), with the majority of the subgroups being sex segregated. High mutual proximity subgroups were more frequent in older children classrooms. This finding agrees with the idea that with age, the increasing coordination of children' association profiles generates more cohesive affiliative structures within the peer group (Strayer & Santos, 1996).

Results of in-group bias analyses showed that HMP membership was clearly associated with higher in-group social preference. This result provides an important validation of the socio-structural analysis by demonstrating the necessary connection between affiliative networks and positive social communication (Kummer, 1971). In addition, it is consistent with the assumption that membership within cohesive subgroups may provide important occasions for the development and maintenance of interpersonal relationships.

Regarding children belonging to LMP subgroups, findings show patterns of in-group bias, which conform to expectations regarding their similar but less selective association. Finding somewhat different patterns of in-group attraction across subgroups suggests that the subgroup types are functionally distinct in these preschool classrooms. High mutual proximity subgroups are more likely to be made up of friends, whereas LMP subgroups are composed of children who do not necessarily share friendship relations. These differences suggest dissimilar degrees of cohesion across subgroup types which could indicate that LMP subgroups are less stable over time. Else, it may be that LMP subgroups are precursors to or even the early stages of HMP groups. Longitudinal data will be needed to test these hypotheses. Overall, findings also indicate that although homophilies may bring subgroups together, it is the affect experienced between co-members that determine whether the subgroup becomes a high or low mutual proximity type. Such affective exchange and the balance of positive *vs.* negative affects may also contribute to subgroup changes through time. Given the fact that HMP co-members are more likely to be friends, an important avenue for future research is to study the potentially different cycles of conflict and reconciliation with co-members versus other classmates.

The introduction of status differentials in the analysis of in-group bias revealed that the salience of co-members as targets of sociometric choices was stronger for members of high and medium status subgroups. For members of higher status subgroups a double process of propinquity/familiarity and attraction to high social acceptance may potentiate in-group sociometric attraction. Subgroup stratification did not significantly influenced in-group bias for social attention or interaction measures (although a small trend was found for social attention). These results, together with fact that the majority of subgroups included children with different sociometric status indicate that the interactive choices of children are not necessarily based on a global assessment of peer likability. It was not the case that the popular children in a classroom only associated with each other.

Stronger in-group bias in 3-year-olds for observational measures can be a result of younger children interacting with a smaller range of their peers. As children grow older they start moving away from playing alone to more interactive types of play (Coplan & Arbeau, 2009; Ladd, 2005; Rubin, Bukowski & Parker, 2006). Children's acquisition of social, cognitive, and communication abilities lies behind these changes (Howes, 2009). The fact that children tend to increase their frequency of social attention and interactions as they grow older (Peceguina, 2010; Shin et al., in press) provides some support for this idea.

From a developmental point of view, an important question concerns whether patterns of association depend upon conscious categorization and social comparison with other members in the peer group. This question seems especially pertinent given the considerable degree of sexual segregation in the obtained affiliative subgroups and the fact that in two of the observational in-group bias variables studied mixed subgroups scored significantly lower than same sex subgroups. That preschool children tend to play with same-sex peers has been documented in the developmental literature since the 1930's (Parten, 1932). However rather than endorsing a cognitive or socio-cognitive model to explain this effect, the majority of past and current research propose complementarity or synchrony in the interactive styles (LaFreniere, Strayer & Gauthier, 1984; Jacklin & Maccoby, 1978; Legault & Strayer, 1993; Martin & Fabes, 2001). From this perspective, children associate in same-sex subgroups because of similarities in behavioral repertoires and styles of social participation.

Another important aspect concerns the current conceptual shift in behavioral biology that inspired research on the functional aspects of dominance for children at the expense of its socio-structural aspects (see Vaughn & Santos, 2009 for a review). Although dominance hierarchies are conceptualized in social ethology as group level structures with functional consequences for the group, these consequences are no longer central topics in current sociobiological/evolutionary psychology research. This loss of diversity in research topics is lamentable because it breaks up historically important ties with concerns of primatologists and sociologists who have studied social influence at the group and subgroup levels.

In future studies, it would be useful to collect both dominance and affiliation data to verify whether dominance status also contributes to preschool subgroup formation, for example if children with similar rank positions in the dominance structure seek out each other as affiliative partners and, if so, whether social dominance also predicts aspects of affiliative subgroup bias.

Overall, the results of in-group bias, do not contradict the contention that peer group affiliative structure constrains individual social attention and acceptance. Given their greater subgroup cohesion, HMP members may play a more salient role in the social adjustment of their co-members. However, the present findings do not permit concluding that some affiliative subgroups have special socializing functions for subgroup members. Independent measures of social influence are necessary to support this claim. Finally, we would also prefer to have classrooms observed longitudinally over the school school year to understand how HMP and LMP subgroup types emerge, their degree of stability or fluidity across time, and how these subgroups influence both individual and group level aspects of social participation.

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Chapter III

Exponential Random Graph Models of Preschool Classrooms

Abstract

Exponential random graph models (ERGMs), or p* models, are probabilistic models that regard observed networks as one particular pattern of ties out of a larger set of possibilities. According to these models, the structure of a network is interpreted as being generated by the overlap of local configurations (e.g., reciprocal ties, transitive triads) that are seen as outcomes of structural processes. Exponential random graph models were used to assess the relevance of reciprocity, popularity, activity dispersion, transitivity and sex homophily effects on the formation of affiliatiave ties, in 19 Portuguese preschool peer groups aged 3 to 5. Data collection involved 200 rounds per class of nearest neighbor focal samples. The number of times two children were recorded as nearest neighbors was used as an indicator of the relationship's strength. The ERGMs yielded a set of parameter estimates and standard errors for each of the 19 preschool classrooms. In order to summarize these independent estimates we followed the multi-level approach to meta-analysis. The estimated average effect sizes indicate statistical significant effects for all parameters, but by far, the strongest effect observed was for reciprocity. Results showed that affiliative ties between preschool children were sex segregated, highly reciprocal, more likely to be directed to a restricted number of children and with a tendency to create transitive triads. Structural effects were very similar between classes and were not influenced by any of the classroom compositional variables (age, size or sex-ratio), excepting for sex homophily effect which was stronger in classrooms of older children. Overall, these results suggest that the processes that underlie preschool peer relations maybe quite stable across classrooms, independently of their age class.

Key words: affiliative structures, exponential random graph models, structural effects

Introduction

Entering preschool, generally at 3 years of age, represents for many children the first opportunity to interact with a great number of peers, setting the stage for their ongoing social development. Children thus become embedded in a social network composed of multiple relationships, influenced by past and anticipated future interactions (or behavioral exchanges) between two individuals (Hinde, 1976a, 1976b).

During the preschool years, peer interactions increase both in frequency and complexity (Howes, 1988) with play activities constituting the main context for them to take place (Power, 2000). This period marks a shift in the form of their solitary and social activities, moving away from playing alone to a more interactive play (Coplan & Arbeau, 2009; Ladd, 2005; Rubin, Bukowski & Parker, 2006). Possibly the most complex type of social interaction reached at this age is sociodramatic play, given it implies that children have the skills to share and coordinate decontextualized and substitutive activities (Coplan & Arbeau, 2009; Goncu, Patt & Kouba, 2002; Rubin et al., 2006). Children's acquisition of social, cognitive, and communication abilities lies behind these developmental changes and without such skills children are not able to make and keep friends (Howes, 2009).

Casual observations in preschool settings easily reveal that such interactions, both affiliative and agonistic, are rarely directed at random to the large number of available partners. Dyadic behavior reflects individual social discrimination, operationalized in terms of the differential allocation of behavior towards other classroom peers (Strayer, 1980). Evidences of selectivity have been documented for more than 70 years (Challman, 1932; Hagman, 1933). As early as age 2, children develop preferences for specific peers that can last for years (Howes, 1988). One of the challenges set to those who study children's social behavior is how to identify (i.e., describe) peer relationships. While interactions can be described quite easily, relationships, and in particular the concept of friendship (the type of dyadic relationship that has received the most attention), are more difficult to measure.

The most common methods used to identify preschoolers' friendships are peer sociometric nominations or behavioral observations. In the dawn of last century, earlier studies using self-reports (Bonser, 1902) were driven by the quest to find the origin of friendship and not so much about defining it since the veracity of self-reports of friendship was unquestioned (Ladd, 2009). The use of observations in the 1920s and early 1930s (Bott, 1928; Challman, 1932; Hagman, 1933; Hubbard, 1929; Wellman, 1926) to study friendship marked a turning point, not only methodologically but also conceptually (Fabes, Martin & Hanish, 2009; Ladd, 2009). Broadly, frequency of association was now the defining feature of friendship (i.e., friends were pairs of children most frequently seen together) and reports of friendship were distinguished from friendship itself, which was now considered an observable phenomena that could be inferred from children's actions. Despite the long lasting criticisms on the ability of young children to identify friendships, most researchers still rely on sociometric nominations to study friendship relations (Fabes et al., 2009; Ladd, 2009; Rubin et al., 2006). For several reasons, observational studies became scarce in the 1950s and 1960s and only in the 1970s when human ethologists entered the scene did developmental psychologists returned to the inside of preschool classrooms (Ladd, 2005; Vaugh & Santos, 2009).

Alongside with this second wave of studies that again inferred social relationships from direct observations, new analytical techniques for describing social networks were introduced, providing new opportunities to analyze the social structure of preschool groups. This set of techniques became collectively known as *social network analysis* (Carrington, Scott & Wasserman, 2005; Scott, 2000; Wasserman & Faust, 1994). Based on mathematical graph theory, its origins can be traced back to the work of Moreno (1934) and others.

Social network analysis sees a social system as a set of nodes connected by edges that represent their relationships and is designed to understand the patterns in relationships among interacting units. The presence of regular patterns in relationships is commonly referred as structure.

Although there are several studies describing affiliative structures of preschool peer groups (Santos, 1990, 1993; Santos, Vaughn & Bonnet, 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008; Santos & Winegar, 1999; Strayer & Santos, 1996; see also Chapter II) we lack studies using statistical models that: (a) allow inferences of whether specific structures in the networks are more common than it would be expected by chance; (b) link such structures with social processes that might have produce them; (c) distinguish the individual contributions of processes that can make similar predictions; and (d) explain how localized social processes and structures combine to form global network patterns (Robins, Pattison, Kalish & Lusher, 2007). Without a statistical model it is difficult to address these questions.

Transitive relations (*friends of friends are my friends*) for example, are one of the main features that differentiate positive interpersonal relationships from a pattern of random ties (Davis, 1970). But, in observed social networks not all relations are transitive, so the tendency towards triadic closure is stochastic rather than deterministic (Snijders, Pattison, Robins, Handock & 2006). Given that there are diverse processes that can lead to transitivity: (a) self-organization of social ties to produce triangular structures (i.e., friends of my friends are likely to become my friends); (b) outcome of tie formation based on popularity[1] (i.e., certain actors may attract ties, including from other popular actors, creating a core-periphery structure with many triangles); and (c) selection of partners based on attribute homophily (i.e, triangles of similar actors are a by-product of homophilous dyadic selection processes); it is important to model transitivity adequately, incorporating effects that make similar predictions so that the relative contribution of each can be assessed (Snijders et al., 2006). Exponential random graph models (ERGMs; or p* models) offer a promising framework within which such models can be developed (Robins & Pattison, 2005; Robins, Pattison et al., 2007; Snijders et al., 2006; Wasserman & Robins, 2005).

Exponential random graph models are probabilistic models that regard observed networks as one realization from a set of possible networks with similar important characteristics (i.e., an observed network is seen as one particular pattern of ties out of a large set of possibilities). In these models each network tie Y_{ij} is regarded as a random variable where Y_{ij} = 1 if there is a network tie from actor i to actor j, and where Y_{ij} = 0 if there is no tie. We specify y_{ij} as the observed value of Y_{ij} with **Y** the matrix of all variables and **y** the matrix of observed ties, the network.

Exponential random graph models have the following form:

$$\Pr(\mathbf{Y} = \mathbf{y}) = \frac{1}{k} exp\{\sum_A \eta_A g_A(\mathbf{y})\} \quad (1)$$

where: the summation is over configuration types A; η_A is the parameter corresponding to configuration of type A; $g_A(\mathbf{y})$ is the network statistic corresponding to configuration A which is a function of **y**; (iv) κ is a normalizing quantity to ensure that (1) is a proper probability distribution.

The model represents a probability distribution of graphs on a fixed node set, where the probability of observing a specific graph is dependent on the presence of different configurations (e.g. reciprocated ties, transitive triads) expressed by the model. The structure

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[1] In this chapter the definition of popularity refers to the existence of higher in-degree nodes, differing from the sociometric definition of popularity, which relates to the verbal assessments of peers as *liked most* and *liked least*.

of a graph can be interpreted as being generated by the overlap of these local configurations that can be seen as outcomes of structural processes in the network. Strength and direction of parameter estimates allow inferences about which configurations are important (e.g., positive and large parameters indicate that the corresponding configuration is more frequent than expected by chance, given other configurations of the model) assisting the judgment about which structural processes could explain how the network emerged.

A convenient way to specify ERGMs is by denoting the conditional probabilities of ties, given the rest of the digraph. The probability that a tie exists is transformed into the natural logarithm of the odds that a tie is present versus absent:

$$\text{logit}\left(\Pr\left(Y_{ij}=1|Y_{ij}^{c}\right)\right)=log\left(\frac{\Pr\,(Y=y_{ij}^{+}}{\Pr\,(Y=y_{ij}^{-}}\right)=\eta_A\left(g_A\left(y_{ij}^{+}\right)-g_A\left(y_{ij}^{-}\right)\right) \quad (2)$$

where: Y_{ij}^{c} is the set of all elements of the adjacency matrix except for Y_{ij}; y_{ij}^{+} denotes the adjacency matrix of the network in which there is a tie from i to *j*; and y_{ij}^{-} the adjacency matrix in which there is no tie from *i* to *j*. The change statistics:

$$d_A(\mathbf{y})=g_A\left(y_{ij}^{+}\right)-g_A\left(y_{ij}^{-}\right) \quad (3)$$

expresses the changes in network statistics when variable Y_{ij} changes from 0 to 1, while the rest of the network is unaltered.

Suppose we had a model with just two parameters η, say for instance arc θ and reciprocity ρ, the first modeling the tendency for nodes to create a tie and the second measuring the extent to which existing ties are reciprocated, with values θ = .5 and ρ = 1 respectively. The associated statistic $g(\mathbf{y})$ for the arc parameter is the number of observed ties $L(\mathbf{y})$ and for the reciprocity parameter the number of mutual ties $M(\mathbf{y})$. If no tie exists between nodes *i* and *j* the log-odds of a tie being present would be calculated as follows:

$$log\left(\frac{\Pr\,(Y=y_{ij}^{+}}{\Pr\,(Y=y_{ij}^{-}}\right)=\theta\left(L\left(y_{ij}^{+}\right)-L\left(y_{ij}^{-}\right)\right)+\rho\left(M\left(y_{ij}^{+}\right)-M\left(y_{ij}^{-}\right)\right)=.5(1)+\ 1(0)=.5$$

The change statistic for the arc parameter is always 1 for any *i* or *j* (i.e., the presence of an additional tie increases 1 in the total number of ties $L(\mathbf{y})$). Given that no tie exists between i and *j*, if one tie is formed between the two, no mutual tie is created and so the change statistic associated with the reciprocity parameter $M(\mathbf{y})$ is 0. On the other hand, if *i* directs a tie to *j*, and the tie from *j* to *i* is already present, the log-odds of the reciprocated tie to exist is:

$$log\left(\frac{\Pr\,(Y=y_{ij}^{+})}{\Pr\,(Y=y_{ij}^{-})}\right) = .5(1) + 1(1) = 1.5$$

In this case the change statistics associated with the reciprocity parameter is 1, because a new tie between j and i creates one more mutual tie. So the log-odds of a tie being present increases by 1 if a tie already exists between the two nodes (and so the odds increase from $e^{.5}$ = 1.65 to $e^{1.5}$ = 4.48).

Although ERGMs are models for single network observations, they assume that networks are generated by a stochastic process in which ties are created depending on the presence or absence of other ties (and possible node attributes as well), conceptualizing the network as a self-organizing system (Robins, Pattison et al., 2007).

The purpose of this study was to examine the influence of different social processes on the creation of affiliative structures of a sample of Portuguese preschool children, namely the influence of reciprocity, popularity, transitivity and sex homophily. Recent findings of a longitudinal study conducted over a school year on 11 North-American classrooms, from the Head Start program, have shown that the importance of the structural effects of reciprocity, popularity and transitivity on relationship formation (and change) *cascades* over time, from the simple to the most complex (Schaefer, Light, Fabes, Hanish & Martin, 2010). Reciprocity effects remained constant along the year, popularity peaked in importance midway through the school year, while triadic closure increased in importance over time. The longitudinal analyses of this study used stochastic actor-based models (see Snijders, van de Bunt & Steglich, 2010 for a recent introduction to these models). These actor-based models share close links with ERGMs.

Even though we lack continuous observations of peer interactions throughout the school year that would allow the detection of possible changes in the influence of these structural effects, ERGMs can still assess the differential impact of each one of them in the creation of the observed networks.

Additionally, a multi-level approach to meta-analysis (Lubbers, 2003; Lubbers & Snijders, 2007) was used to analyze the extent to which the several effects generalize across different classrooms and how possible differences might be related to classroom characteristics. Schaefer et al. (2010) did not asses these possible differences, because, in order to circumvent the difficulty of obtaining reliable parameter estimates for their models (which can happen for small networks), they analyze all networks simultaneously by arranging their data as one large matrix with structural zeros (permanent null ties) between children in different classrooms (Snijders, Steglich, Schweinberger & Huisman, 2008). By doing this, they assumed that parameter values are equal across classrooms.

Method

Participants

Observational data were collected in 19 preschool classrooms in two different centers serving middle class families in the region near Lisbon, Portugal, as part of a larger study on preschool children social development initiated on 2004. The sample (N = 455) has total of 142 children in six *3-year-olds* classes (i.e., children < 48 months of age at the start of the academic year, 69 girls, 73 boys), 143 in six *4-year-olds* classes (i.e., children between 48 and 60 months of age at the start of the academic year, 72 girls, 71 boys) and 170 in seven *5-year-olds* classes (i.e., children between 60 and 72 months of age at the start of the academic year, 88 girls, 82 boys). Classrooms were sampled once (n = 2), twice (n = 4) or in all three consecutive years (n = 3). On average, 83 % of the children transit together from one year to the next. Classrooms ranged in size from 20 to 27 children, with sex-ratios between .40 and .68.

Social proximity observations

Using a focal individual sampling design, children were observed in a randomly determined order for a 15-s interval. At the end of the sampling interval, the child's nearest peer neighbor was identified. A peer who was within arm's reach (roughly 3-4 feet) and engaged in the same or a similar activity as the target child was considered the nearest neighbor of the target. If two or more children were equally close to the focal child the peer to the child's immediate right was considered as nearest neighbor. For instances in which a child was interacting verbally or physically with a peer at the end of the 15-s interval, the interacting partner was considered as the nearest neighbor, even though another child might be physically closer. Two observers made 200 observation rounds per classroom (100 rounds each; one round corresponds to observing every child present once). Social proximity rounds were interspersed with rounds of other observational data. Children absent from the classroom for 50% or more of the observational rounds were excluded from the analysis. Observational assessments for a given classroom took around three weeks to complete.

Research assistants received training in the observation schedule prior to initiating classroom observations. Rater agreement was estimated as the alpha coefficient for individual rate scores across raters. That is, the vector of rate scores from the observations of one observer was treated as a single "item" and the standard internal consistency estimate (Cronbach's alpha) was calculated. This estimate assesses the representativeness of scores contributed by individual observers, rather than agreement per se of the nearest neighbor of one specific child. Mean (± *SD*) reliability estimates were .86 (± .10).

Social network measurement

The number of times two children were recorded as nearest neighbors was used as an indicator of the relationship strength. This approach has been successfully used in several studies (Santos, 1990, 1993; Santos et al., 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008) investigating the cohesive structure of preschool peer groups. Dyadic co-occurrence data were filtered as follows:

$$Y_{ij} = 1\ if\ \frac{o_{ij}}{o_{i+}} > 2\frac{1}{N-1} \quad (4)$$

A tie from child *i* to child j (Y_{ij}) was treated as having weight 1 if the number of times *i* and *j* were nearest neighbors o_{ij} divided by the number of times *i* was observed with another child o_{i+} exceeded twice the proportion expected by chance (*N* equals the number of children in the classroom). Edges filtered this away allow asymmetric ties, retaining only the stronger connections for each child, the ones likely to represent meaningful social relationships. Filtering edges always involves some degree of arbitrariness and at the moment there is not a generally accepted approach for doing so (Croft, James & Krause, 2008), but, as the majority of network analyses, exponential random graph models require binary networks.

Model specification

To assess the relevance of the different structural processes we fitted a exponential random graph model, to each observed classroom network, that included five structural parameters (*reciprocity*, *alternating k-instar*, *alternating k-outstar*, *alternating k-triangle transitive* and *mixed-2-star*; Figure 1) controlling for sex homophily effects.

The corresponding network statistics are defined as follows:

reciprocity: $g_1(y) = \sum_{i<j} y_{ij}\, y_{ji}$ (5)

alternating *k*-instar: $g_2(y) = \sum_{k=2}^{n-1}(-1)^k \frac{S_{k_{in}}}{\lambda^{k-2}}$ (6)

alternating k-outstar: $g_3(y) = \sum_{k=2}^{n-1}(-1)^k \frac{S_{k_{out}}}{\lambda^{k-2}}$ (7)

alternating k-triangle transitive: $g_4(y) = \sum_{k=2}^{n-1}(-1)^k \frac{T_{k_{transitive}}}{\lambda^{k-2}}$ (8)

mixed-2-star: $g_5(y) = \sum_{i,j,k} y_{ji} y_{ik}$ (9)

sex homophily: $g_6(y) = \sum_{i,j} y_{ij} samegender_{ij}$ (10)

where: S_k is the number of k-stars (i.e., the number of stars with k edges); T_k is the number of k-transitive triangles (i.e., the number of times nodes i and j, connected by and edge are also connected to k other nodes, forming a transitive triangle); and λ is a weighting parameter.

For reciprocity, mixed-2-star and sex homophily these network statistics are simply configuration counts (e.g., network reciprocity statistics equals the number of mutual ties observed in the graph as described in the example presented above, and so on). For alternating k-instars, k-outstars and k-transitive triangles network statistics are weighted sums with alternating signs of the number of different order configurations (e.g., the network alternating k-instar statistics is a weighted sum with alternating signs of the number of 2-instars, 3-instars, …, k_{max}-instars). The alternating k parameters are recent specifications for exponential random graph models that improved the fit of these models to empirical network data (Snijders et al., 2006). With previous specifications (Markov models) star parameters were (in most case) limited to a maximum of 3-stars, with higher order stars parameters (e.g., 4-stars, 5-stars, …, k-stars) set to 0. The alternating k-star parameter captures all these star effects simultaneously.

The reciprocity parameter, as the name implies, models reciprocation. A positive parameter indicates a high tendency to create reciprocal relations. The alternating k-star parameters are intended to assist with modeling the degree distribution (k-instar and k-outstar parameters for in-degree/popularity and out-degree/activity distributions respectively). A positive alternating k-star parameter indicates that the network has a skewed degree distribution, containing some higher degree nodes, whereas a negative parameter suggests that nodes with high degree are improbable (i.e., smaller variance between the degrees). Also, a positive parameter suggests a preference for connections between a larger number of low degree nodes and a smaller number of higher degree nodes, similar to a core-periphery structure. To help model degree distribution and improve model fit (see next section), we also included the mixed-2-star parameter.

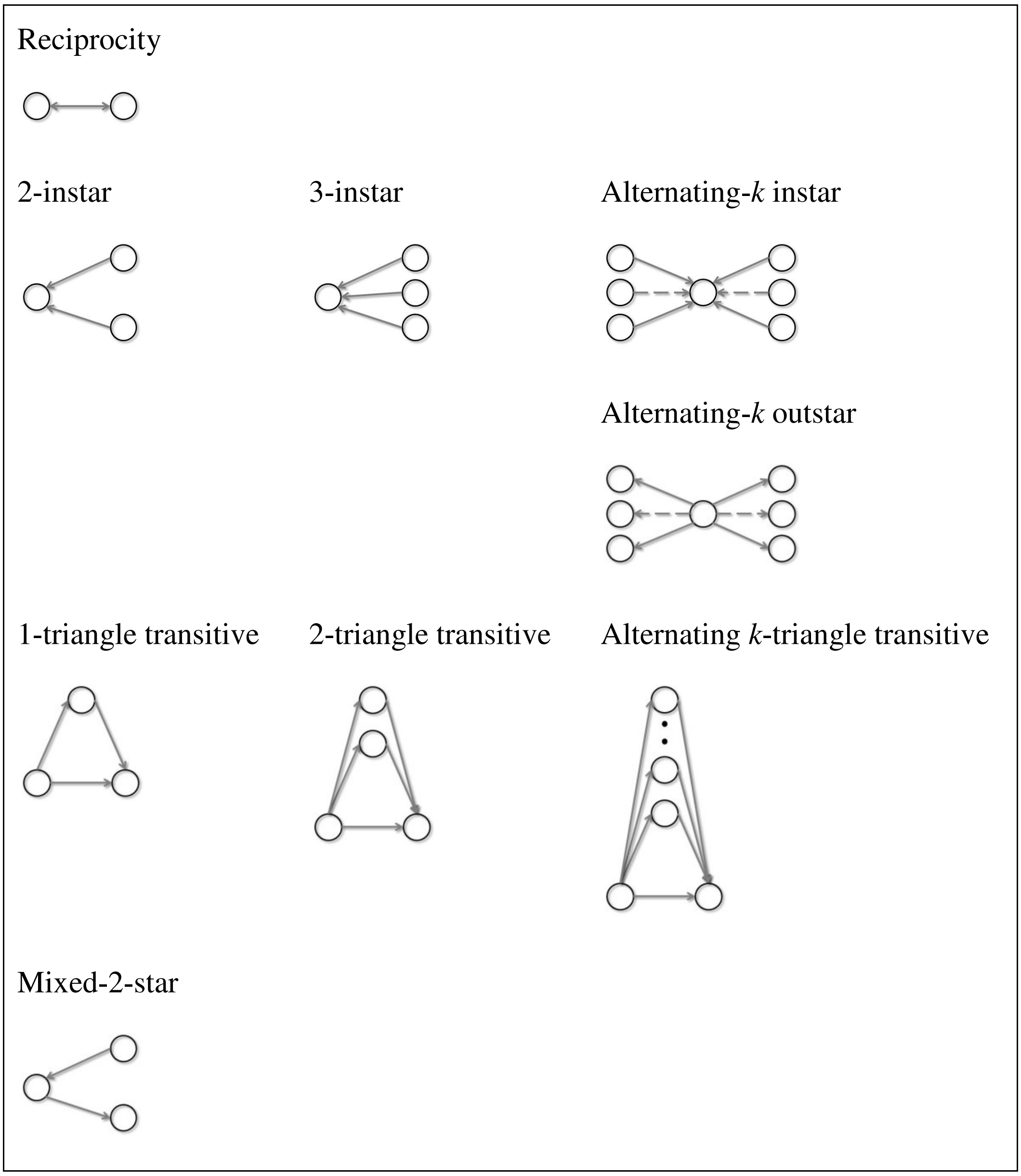

Figure 1

Structural Configurations

Note. Additional star and triangle configurations, not specified in the model, were included in the figure to better illustrate the concept of alternating *k* configurations.

For values of the weighting parameter λ (Eq. 6-7) greater than one, the impact of higher order stars is reduced for higher *k*, since the preference for high degree nodes is not linear in degree. The marginal gain in log-odds for connections to increasingly higher degree nodes is geometrically decreasing with degree. In other words, the benefit of adding an additional tie decreases geometrically with the degree of the nodes involved. For instance, with $\lambda = 2$ in Eq. (6), and positive alternating *k*-instar parameter, for node *i*, a connection to a node j_1 who has an in-degree of 2 is more probable than a connection to j_2 with only 1 in-degree, while if j_1 and j_2 have in-degrees 5 and 6 respectively, the conditional probability of a tie being present between j_1 or j_2 is very similar. So, nodes with degree five and higher are treated almost equivalently (Robins, Pattison et al., 2007; Snijders et al., 2006).

The alternating *k*-triangle transitive parameter measures the tendency to form transitive relations and the extent to which triangles themselves group together in the network. A positive *k*-triangle parameter can be interpreted as evidence for transitivity effects. Similarly to the alternating *k*-stars, with $\lambda = 2$ in Eq. (8) and positive value for the parameter, the conditional log-odds of a tie between *i* an *j* being observed does not increase strongly as a function of *k* for values of *k* above 4 or 5 (unless for larger parameter values), expressing the notion that the first one to three shared partners are the ones that most influence transitive closure, with additional partners not substantially increasing the odds of a tie being formed (Snijders et al., 2006). In directed networks there are different types of triangles that can be created (Robins, Patison & Wang, 2009), but is usually sufficient to infer a general triangulation effect from the alternating *k*-triangle transitive parameter (Robins et al., 2009).

In this study we set $\lambda = 2$ for the three alternating *k* parameters, which has been shown to work well in other investigations (Goodreau, 2007; Lubbers & Snijders, 2007; Robins et al., 2009; Robins, Snijders, Wang, Handcock & Pattison, 2007; Snijders et al., 2006). An optimal value for λ can be estimated, although doing so can dramatically increase computation time and the model would no longer be a standard exponential random graph model (Hunter, 2007; Hunter & Handcock, 2006).

Finally, the sex homophily parameter measures the tendency for social ties to develop between actors with the same sex.

The different parameter estimates are compared with their corresponding standard errors to give an idea of the effect significance. The distribution of this statistic (parameter estimate divided by standard error) is not known, but likely to approximate a *t* distribution (Snijders, 2002). Ratios exceeding two in absolute magnitude suggest non-zero effects.

All models were fitted using the pnet software (Wang, Robins & Pattison, 2006), conditioned on the number of ties (i.e., the number of ties were fixed during Monte Carlo estimation procedures). Fixing density is designed to diminish the risk of degeneracy problems (non-convergence of the parameters; see below), having minor effects on other parameter estimates (Robins, Snijders et al., 2007; Snijders et al., 2006).

Model selection and goodness of fit

The first requirement for a model to fit well is that the estimation of parameters to converge on finite parameter values, meaning that model parameters can reproduce the number of corresponding configurations. Parameters are estimated using Markov chain Monte Carlo methods (Snijders, 2002; Snijders et al., 2006). Generally, the central approach of these methods consists in simulating a distribution of random graphs from a starting set of parameter values, which are subsequently refined by comparing the distribution of graphs against the observed graph. This process is repeated until the parameter estimates stabilize. Parameters are said to have converged when the mean number of configurations in the sample of simulated graphs is similar to number of configurations in the observed graph:

$$t - ratio = \frac{(observation - mean\ sample)}{standard\ deviation} \qquad (11)$$

Good convergence is indicated by a *t*-ratio for all parameter estimates being less than (or close to) .1 in absolute value. So, for a model with just reciprocity and triangle parameters, both parameters converge if the mean number of mutual ties and triangles in a sample of simulated graphs is similar to the number of mutual ties and triangles observed in the data.

After parameters have been estimated from an observed network, we investigated how well the model parameters succeeded in replicating other features of the observed graph that were not explicitly modeled. If simulations based on the model estimates can reproduce these additional features, then the model can be considered a good representation of the observed network (i.e., the model has a good fit). There are a great number of these features on which to examine any model and no general rule for selecting such features. The network statistics we compared included: standard deviations and skewness of both in-degree and out-degree distributions; correlation between the in-degree and out-degree distribution; and a set of eight global clustering coefficients (see Robins et al., 2009 for details). A *t*-ratio for these statistics less than 2 in absolute value is not regarded as bad fit, although preferably *t*-ratios should lie between -1 and 1 (Robins et al., 2009; Robins, Snijders et al., 2007).

Modeling the variability between classes

The exponential random graph analyses yielded a set of parameter estimates and standard errors for each of the 19 preschool classrooms. In order to summarize these independent estimates we followed the multi-level approach to meta-analysis described in Lubbers (2003) and Lubber and Snijders (2007). The major advantage of using this approach instead of classical meta-analysis techniques is that it is simple to include variables in the model, such as classroom size, which may explain the variability of the effects between classrooms (Hox, 2002).

Let η denote one of the parameters. Each of the 19 classrooms has its own true parameter value which is assumed to be a random sample from the parameter values in a population of classrooms (Snijders & Baerveldt, 2003). The multilevel regression equation can be written as:

$$\hat{\eta}_m = \mu_\eta + U_m + E_m \tag{12}$$

where $\hat{\eta}_m$ denotes the estimated parameter value for classroom *m*, μ_η the average parameter in the population of classrooms, U_m the true deviation of classroom *m* from μ_η, which has a mean of 0 and a variance σ_η^2, and E_m the estimation error associated with the true parameter value μ_η. The variance of E_m is assumed to be known, and equal to the squared standard error obtained when estimating η_m.

The average effect size μ_η of a parameter measures to what extent that network effect occurs in the set of all classrooms and the variance σ_η^2 represents the between classrooms variance. We used MLwiN software (Rasbash, Charlton, Browne, Healy & Cameron, 2009) to estimate μ_η and σ_η^2. Following the multilevel approach to meta-analysis we created a pseudo-level with each unit at level 2 having only one observation at level 1, with the error variance var(E_m) specified at level 1 and the true variance σ_η^2 modeled at level 2 (Goldstein, 1995).

A *t*-ratio of the average parameter estimate tests whether the average effect size μ_η is zero.

$$t_{\mu_\eta} = \frac{\hat{\mu}_\eta^{WLS}}{S.E.(\hat{\mu}_\eta^{WLS})} \tag{13}$$

Both $\hat{\mu}_\eta^{WLS}$ and SE ($\hat{\mu}_\eta^{WLS}$) are produced by MLwiN. This statistic has approximately a standard normal distribution. Ratios exceeding 1.96 in absolute magnitude indicate a non-zero average effect size. The superscript of $\hat{\mu}_\eta$ (WLS) refers to the iterated estimation of the weighed least squares used in multi-level modeling.

To test whether between classrooms variance σ_η^2 is zero, the following statistic is used (Snijders & Baerveldt, 2003):

$$Q = \sum_m \left(\frac{\hat{\eta}_m}{S.E.(\hat{\eta}_m)}\right)^2 - \left(\frac{\sum_m \hat{\eta}_m / S.E.(\hat{\eta}_m)^2}{\sqrt{\sum_m 1/S.E.(\hat{\eta}_m)^2}}\right)^2 \quad (14)$$

which has approximately a χ^2 distribution and $N - 1$ degrees of freedom, where N is the number of classrooms.

Eq. (12) can be expanded to include classrooms characteristics that explain the variability of the effects between classrooms:

$$\hat{\eta}_m = \gamma_0 + \sum_h \gamma_h W_{hm} + U_m + E_m \quad (15)$$

where γ_0 is the intercept and γ_h the h coefficients for the explanatory variables at class level W_{hm}. The estimated parameters were regressed on three explanatory variables: age class, classroom size and sex-ratio. Age class was entered in the regression model as categorical variable. Both classroom size and sex-ratio were grand-mean centered (i.e., the overall mean is subtracted from all values of a variable). Centering variables gives the intercept a clear interpretation; it represents the effect size for a classroom with the average size and sex-ratio of the sample (and for 3-year-olds). Without centering, the intercept would be the average effect size for a classroom with zero children and zero sex-ratio (all children from the same sex).

Results

Descriptive statistics

After filtering co-occurrence matrices the networks created had an average out-degree ranging from 1.72 to 4.07. Tables 1 to 3 present a set of descriptive statistics for the preschool classrooms studied. These tables give some initial insights on the structural processes that might be in the origin of the networks observed. Individual out-degree and in-degree ranged from 0 to 7 and 0 to 10 respectively. Classroom standard deviations for these statistics also reflected a more skewed distribution for in-degree. On average 77.14% (*SD* = 6.59) of all ties were reciprocated and highly sex segregated (*M* ± *SD* = 78.63% ± 10.17%). The transitivity index presented in Tables 1 to 3 is a cluster coefficient that measures the proportion of alternating *k*-2-paths (the higher order configuration of mixed-2-star) that have a base present to complete an alternating *k*-triangle transitive. Average values for this index lied between .11 and .47.

Table 1

Descriptive Statistics for 3-Year-Olds Affiliative Networks

Classroom	**A1**	**B1**	**C1**	**D1**	**F1**	**I1**
N	20	24	24	24	25	25
Sex-ratio	.42	.50	.46	.58	.60	.56
Out-degree						
M	2.25	3.46	3.67	2.46	1.72	2.84
SD	.55	1.02	1.24	1.14	1.02	.75
Range	1 - 3	2 - 6	1 - 6	0 - 5	0 - 3	2 - 4
In-degree						
SD	1.16	1.47	2.16	1.47	1.14	1.86
Range	0 - 5	1 - 7	0 - 8	0 - 6	0 - 5	0 - 7
Reciprocity index	.80	.84	.70	.81	.70	.68
Transitivity index	.46	.24	.25	.34	.11	.16
% same sex ties	.58	.71	.72	.66	.65	.79

Note. Sex-ratio represents the % of boys in each class (same as Tables 2 and 3). Mean in-degree values are not presented because they are equal to mean out-degree values (i.e., the number of sent and received ties is the same).

Table 2

Descriptive Statistics for 4-Year-Olds Affiliative Networks

Classroom	**A2**	**B2**	**D2**	**E1**	**G1**	**I2**
N	20	25	25	24	25	24
Sex-ratio	.40	.48	.68	.46	.44	.50
Out-degree						
M	2.55	3.04	2.96	2.38	2.48	3.75
SD	.89	.98	1.06	1.24	.96	.94
Range	1 - 4	2 - 5	1 - 5	0 - 5	1 - 4	2 - 5
In-degree						
SD	1.43	1.74	1.54	1.56	1.48	1.51
Range	0 -5	1 - 7	0 - 6	0 - 5	0 - 5	1 - 6
Reciprocity index	.63	.74	.76	.74	.74	.84
Transitivity index	.16	.38	.18	.24	.18	.25
% same sex ties	.69	.80	.80	.77	.81	.86

Table 3

Descriptive Statistics for 5-Year-Olds Affiliative Networks

Classroom	**A3**	**B3**	**C2**	**E2**	**G2**	**H1**	**I3**
N	22	27	25	21	25	25	25
Sex-ratio	.50	.52	.52	.43	.40	.44	.56
Out-degree							
M	3.09	4.07	2.72	2.81	3.08	3.68	3.72
SD	.75	1.27	1.14	1.08	1.04	1.07	1.14
Range	2 - 5	2 - 7	1 - 4	1 - 5	1 - 5	2 - 6	1 - 6
In-degree							
SD	1.85	2.27	1.28	1.12	1.63	2.10	1.77
Range	0 - 7	1 - 10	1 - 6	1 - 5	1 - 6	1 - 8	1 - 8
Reciprocity index	.79	.80	.88	.85	.75	.78	.82
Transitivity index	.28	.39	.47	.31	.30	.28	.17
% same sex ties	.81	.87	.96	.93	.92	.86	.76

Summary of exponential random graphs model

Exponential random graph models were estimated with the network effects reciprocity, alternating *k*-instar, alternating *k*-outstar, alternating *k*-triangle transitive, mixed-2-star and sex homophily for the 19 preschool networks. Models converged successfully with all *t*-ratios between -.1 and .1 ($M \pm SD = .04 \pm .03$, absolute values). Table 4 resumes the average effect sizes for each of the parameters.

Table 4

Meta-Analysis of Parameter Estimates

	$\hat{\mu}_{WLS}$	SE	σ^2	Q
Reciprocity	4.78**	.16	.00	17.15
Alternating k-instar	1.21**	.13	.00	12.93
Alternating k-out star	-.73*	.30	.44	32.58*
Alternating k-triangle transitive	.41**	.05	.02	12.66
Mixed-2-star	-.57**	.05	.01	27.40
Same gender	.78*	.07	.00	19.52

Note. $\hat{\mu}_{WLS}$ - estimated average effect size; *SE* - standard error associated to estimated average effect size; σ^2 - estimated variance of the effect size between classes; Q - statistic for testing whether the variance of the effect is zero. * $p < .05$, ** $p < .01$.

The estimated average effect sizes indicate statistical significant effects for all parameters, but by far, the strongest effect observed was for reciprocity. A high value for the reciprocity parameter (4.78) was to be expected because almost 80% of the ties are mutual ties. A significant positive value for alternating *k*-instar parameter (1.21) tells us that in-degree distribution is skewed with some highly popular nodes, indicating that some children were clearly preferred than others as association partners. A significant negative value for alternating *k*-outstar parameter (-.73) reflects a homogeneous out-degree distribution, with children establishing more or less the same number of "strong relationships".

Positive alternating *k*-triangle transitive (.41) and negative mixed-2-star parameter (-.57) can be interpreted together, suggesting a tendency for transitivity. The positive *k*-triangle parameter tells us that children tend to spend time with the preferred choices of their partners. The negative mixed-2-star indicates a tendency against non-closed paths (as expected by the significant positive *k*-triangle parameter). The positive value for the sex parameter reflects a tendency for sex segregated ties. Positive values for alternating *k*-instar and alternating *k*-

triangle transitive parameters indicate the existence of a core in the preschool networks, created by both popularity and triadic closure effects.

Models had generally a good fit, reproducing well a set of features of the observed networks: standard deviations and skewness of both in-degree and out-degree distributions; correlation between the in-degree and out-degree distribution; and eight global clustering coefficients. Absolute values of *t*-ratios for these configurations were below 1 in 11 classrooms. One classroom had one *t*-ratio higher than 2 (skew in-degree distribution), and the remaining had either one (n = 5) or two (n = 2) *t*-ratios ranging between 1 and 2 in magnitude.

Classroom composition and network structure

The variance of the network effects was very small (Table 4), indicating these were consistent across classes, excepting for alternating *k*-outstar which was more variable between classrooms. Group compositional variables (age class, classroom size and sex-ratio) were added to the multilevel model as class level covariates. Results are presented in Table 5.

As indicated, none of the group composition variables had an impact on the network structure of preschoolers, excepting for an age effect on sex homophily. Older children were more likely to have ties with same sex children. The odds of a tie between same sex partners was 1.68 ($e^{.52}$ = 1.68) for 3-year-olds, 2.23 for 4-year-olds and 2.80 for 5-year-olds.

Table 5

Effects of Group Composition (Regression Coefficients)

Reciprocity	4.84 (.32)	**Alternating *k*-triangle transitive**	.43 (.08)
Age class		Age class	
4-year-olds	-.11 (.43)	4-year-olds	-.08 (.12)
5-year-olds	-.02 (.44)	5-year-olds	-.01 (.12)
Classroom size	-.06 (.11)	Classroom size	.02 (.03)
Sex-ratio	3.91 (2.69)	Sex-ratio	-.72 (.72)
Alternating *k*-instar	1.28 (.24)	**Mixed-2-star**	-.61 (.07)
Age class		Age class	
4-year-olds	.05 (.33)	4-year-olds	-.07 (.10)
5-year-olds	-.32 (.36)	5-year-olds	.13 (.10)
Classroom size	.08 (.33)	Classroom size	.04 (.03)
Sex-ratio	-.59 (2.03)	Sex-ratio	-.53 (.62)
Alternating *k*-outstar	-.76 (.56)	**Sex similarity**	.52
Age class		Age class	
4-year-olds	.08 (.75)	4-year-olds	.28 (.17)
5-year-olds	.03 (.81)	5-year-olds	.51 (.18)*
Classroom size	-.04 (.22)	Classroom size	-.04 (.05)
Sex-ratio	3.89 (4.64)	Sex-ratio	-.21 (1.14)

Note. For “Age class” only two levels are presented (4- and 5-year-olds) since the estimates represent how much they differ from 3-year-olds. Regression coefficients associated with structural parameters represent model intercepts. Standard errors are in parentheses. * $p < .05$.

Discussion

The purpose of this study was, first, to examine the influence of different social processes on the development of affiliative social structures within Portuguese preschool classrooms and, second, to analyze the extent to which these processes can be generalized across different classrooms and how possible differences could be related to classroom characteristics. With affiliative relationships defined using frequency of associations collected through directed observations in natural settings, results showed that affiliative ties between preschool children were sex segregated, highly reciprocal, more likely to be directed at popular children and with a tendency to create transitive triads. Structural effects were very similar between classes, excepting for activity (alternating *k*-outstar parameter). Even though the out-degree distribution was homogeneous within classrooms, the extent of this homogeneity varied between them. This variability could not be explained by any of the classroom compositional variables (age, size or sex-ratio). Additionally, only one of these classroom descriptors had an effect on one of the parameter estimates – sex homophily effect was stronger in classrooms of older children.

Increased sex segregation with age confirms the ubiquity of sex-segregated patterns of social interaction and its central role in the social organization of preschool peer groups, especially as children grow older (Martin, Fabes, Hanish & Hollenstein, 2005). Early research on peer selection processes focused on the role of sex segregation. Appearing around the 3 years of age sex segregation is probably the most noticeable feature of early peer relationships (Bohn-Gettler et al., 2010; Fabes, Martin & Hanish, 2003; LaFreniere, Strayer & Gauthier, 1984; Maccoby & Jacklin, 1987; Martin & Fabes, 2001; Martin et al. 2005; Pellegrini, Long, Roseth, Bohn & Ryzin, 2007). Although the tendency to seek out same-sex partners can both reinforce and shape developmental sex type behavior, preschool children do not choose random playmates from the available same sex partners. Behavioral homophily has been shown to also influence selection – preschoolers tend to be attracted to peers whose behavioral tendencies are similar to their own (Hanish, Martin, Fabes, Leonard & Herzog, 2005; Martin, et al. 2005; Pellegrini et al., 2007). However behavioral homophilies are often sex typed, making it difficult to distinguish both processes (Fabes, Martin & Hanish, 2004).

Reciprocity is a defining feature of social life (Molm, 2010) and very common in preschool networks (Schaefer et al., 2010; Snyder, West, Stockemer & Gibbons, 1996). The emergence of reciprocal relations involves minimal information-procession requirements given that individuals only need to return his/her partners' gestures, not needing to be aware of other relationships (Schaefer et al., 2010). Filtering edges from symmetric co-occurrence matrices might be boosting the effect of reciprocity. The logic behind the use of a symmetric matrix for this type of data (i.e., nearest neighbor) has to do with the fact that no information is collected of who is the initiator of the interaction that led to proximity, and so we consider *i* and *j* to be associated if either *i* is *j*'s nearest neighbor, or *j* is *i*'s nearest neighbor (although in some cases *i* can be the nearest neighbor of *j* but *j* does not necessarily has to be the nearest neighbor of *i*). That is, although, two individuals might be seen together in a regular basis, it maybe that only one member of the dyad is responsible for all the proximity seeking. So we should be cautious when talking about reciprocity when using data that do not come from behavioral exchanges that have clear initiators.

Though analyses for weighted networks have been developed in the last years (Barthélemy, Barrat, Pastor-Satorras & Vespignani, 2005; Newman, 2004) the great majority of social network analyses require directed or undirected binary networks. This is a drawback, especially for those who infer social relationships from observational data. Filtering edges is always somehow arbitrary and information like the "importance of weak ties" (Granovetter, 1973) is lost along the way.

Existence of some higher in-degree nodes can be an emergent phenomenon reflecting underlying variations in individual characteristics (Gould, 2002) that enhance or decrease the probability of a child being selected as an interaction partner, or it can reflect a more complex process of preferential attachment (Barabási & Albert, 1999), where relationships are driven by popularity itself, with children associating with peers because they are preferred partners of a significant number of others. In this sense, the role of preferential attachment in shaping relationships is also more complex than reciprocity, because one has to be aware of other relationship excluding one's own (Schaefer et al., 2010). Despite the differences, both processes make similar predictions for single network observations (existence of higher in-degree nodes) that cannot be distinguished using the exponential random graph models (ERGMs) framework used here. In a longitudinal perspective, preferential attachment would continuously bias in-degree distributions, as some children would become more and more popular as time goes by. If what shapes relationships is the assessment of individual characteristics that make a child more or less preferred, than it is expected that popularity effect maxes out after children had time to assess the "quality" of their peers. Schaefer et al.'s (2010) findings support the later process, with popularity effects peaking in importance in the middle of the school year and remaining constant thereafter. In reality the process might even be more dynamic than this since the "quality" of a child as partner may not be a fixed property co-evolving alongside the creation of new relational ties.

Triadic closure requires the pre-existence of two relationships, contrarily to reciprocity which only needs one, and some sort of knowledge of partners' relationships. As such, it is expected to occur in latter periods of network formation. Schaefer et al.'s (2010) findings support this idea. Despite the cascading effects found by Schaefer et al. (2010), a closer look at their models reveals that the change in the popularity and transitivity parameters value, across three time periods in a school year, only slightly changes the odds of a tie being created. Changes in odds-ratio of relationship formation through these processes, across time, were less than .5. In addition, no model was run including both popularity and transitivity together. Without this, it is not possible to analyze the effects of each individual process taking into account the effect of the other. For example, cores in networks can arise either by closure-type processes or from popularity (or a combination of the two) and without analyzing them together the different effects cannot be parceled out (Robins et al., 2009). Schaefer et al. (2010) also modeled the number of denser triads (triads where all six possible ties are present) to measure the amount of reciprocation within triads. Changes in time on the number of denser triads were more marked than popularity and transitivity effects, although none of the three effects was modeled together.

The positive popularity and triadic closure effects observed in our sample indicate the presence of core-periphery structure in the networks, created by the conjunction of both effects. Previous applications of ERGMs pointed out that the formation of a core was often the result of, either, popularity or a triadic closure effect, seldom both (Robins et al., 2009). The combination of both effects may turn out to be not as unusual as previously thought.

Results showed that the structural effects of reciprocity, popularity and transitivity do not vary much between classrooms of 3-, 4- or 5-year-olds. Together with Schaefer et al.'s (2010) findings this may indicate that these network processes do not vary a lot within the preschool years.

Recently, Fujisawa and colleagues (Fujisawa, Kutsukake & Hasegawa, 2008, 2009) used behavioral data to describe what they called "affiliative network structure" (or "positive network") and "disruptive network structure" (or "negative network"). Their results suggest that the structural processes influencing affiliative and agonistic interactions are not necessarily the same. It would be very interesting to extend these results using a random graph models approach to multiple relations (Koehly & Pattison, 2005). In this way we could study the network processes and the interdependencies of both types of ties simultaneously.

In sum, the goal of this study was to reveal the processes that underlie preschool affiliative peer relations using ERGMs. Results showed that these processes were quite stable across a sample of 19 preschool classrooms, independently of their age class. We hope we have contributed somehow to show the benefits of a stochastic modeling approach to the analysis of preschool children social networks.

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Chapter IV

Affiliative Structures and Social Competence in Preschool Children

Abstract

Social competence construct can be described as an individual differences latent trait that reflects children's ability to coordinate affect, cognition, and behavior in achieving personal social goals. Seven indicators were used to characterize three broad domains of social competence: *social motivation and engagement*, *profiles of behavioral and psychological attributes*, and *peer acceptance*. The goal of this study was to assess the extent to which individual levels of social competence were related to the cohesion of the affiliative subgroups to which children belong. Results showed that children belonging to more cohesive affiliative subgroups had higher levels of social competence than children belonging to less cohesive subgroups, and that ungrouped children were generally the least competent. Results also indicate that the constitution of subgroups is very fluid, but despite these changes, children in cohesive subgroups tend to maintain themselves in this type of subgroups, indicating some continuity in the organization of behavioral patterns.

Key words: affiliative structures, preschool children, social competence

Introduction

Social competence is a difficult concept to define, having a wide range of descriptions, that go from specific characterizations (e.g., collection of specific skills and behaviors, Dodge, 1986; Dodge, Murphy & Buchsbaum, 1984) to broader definitions implying that social competence is better understood as an organizational construct that reflects the quality of adaptation in the peer group (Waters & Sroufe, 1983).

Given the difficulties to operationalize social competence, using several distinct indicators of social competence seems to work better than using a single measure or trait approach (Bost, Vaughn, Washington, Cielinski & Bradbard, 1998; Rose-Krasnor, 1997; Vaughn, 2001; Waters & Sroufe, 1983). Following the first method, social competence can be seen as a broad functional construct that requires complementary techniques of assessment, covering a wide range of social domains in order to reach a global characterization. These methods should assess social competence as the capacity of individuals to flexible manage the behavioral, affective, and cognitive resources available to them to attain social goals without entering into social trajectories that reduce the chances of accomplishment of future social goals, and without excessively constraining peers' opportunities in achieving their own social goals (Rose-Krasnor, 1997; Bost et al., 1998; Waters & Sroufe, 1983). Defining social competence with this level of abstraction allows the definition to be applied across a range of ages, even though the behavioral, affective, and cognitive resources available and the tactics used change with age. In addition, this definition also entails the assumption that present social competence affects social competence in subsequent developmental periods (Howes, 1988; Waters & Sroufe, 1983). That is, if children are presently successful in their social competence with peers, they should be more prepared to face future social demands.

This global approach also has the advantage over more specific characterizations (e.g., social competence as the ability to develop and maintain reciprocal friendships; Hartup, 1989; Rose-Krasnor, 1997) of expecting diversity on behavioral indicators of social competence across different developmental, cultural, and social contexts (Chen, Rubin & Sun, 1992). A critical task in adopting this approach concerns the selection of measures to assess normative growth and individual differences among children.

For preschool children, being accepted by the peer group (Bukowsky & Hoza, 1988; Bukowsky, Newcomb & Hartup, 1996; Ladd, 2005), and initiate and respond to others with positive affect (Waters & Sroufe, 1983) are important features of children's social competence. Previous studies in this age group using general measures, rather than specific skills, to assess social competence have suggested that this construct is appropriately described as a hierarchical structure with three subordinate factors (or measurement families) – *social motivation and engagement*, children's *profiles of behavioral and psychological attributes*, and *peer acceptance* – that summarize a range of intra- and interpersonal behavioral tactics relevant to goal achievement in social contexts (Bost et al., 1998; Peceguina, 2010; Shin et al., in press; Vaughn, 2001; Vaughn et al., 2009). Each of these measurement families is hypothesized to influence children's performance in seven measured variables (two or three indicators per family).

The first family – social motivation and engagement – includes three different indicators: (a) rates of visual attention received; (b) rates of positive interactions initiated; and (c) rates of neutral interactions initiated. The use of these indicators is grounded on the assumption that children have the need to establish themselves within the peer group (Omark & Edelman, 1976) and change their behaviors and interactions in response to group expectations (Harris, 1995). The rate of visual attention a child receives from peers has been shown to significantly correlate with Q-sort measures of social competence (Vaughn & Martino, 1988; Waters, Garber, Gornal & Vaughn, 1983; Waters, Noyes, Vaughn & Ricks, 1985) and sociometric preferences (Vaughn & Waters, 1981). In addition, correlations with visual attention measures indicate that socially competent children receive proportionally higher rates of visual attention from peers (Vaughn & Martino, 1988). Children who received higher rates of visual attention were also described, by adult observers, as socially oriented, motivated, and skilled (Vaughn & Martino, 1988).

Concerning children's interactions, three types have been commonly investigated: (a) movement toward others; (b) movement against others; and (c) movement away from others (Rubin, Bukowsky & Parker, 2006). Generally and regardless of the diversity of social interactions, children who move toward others are considered sociable. Those who move against others are typically characterized as aggressive and those who move away from others are said to be socially withdrawn. The initiation of positive and neutral interactions is generally positively associated with children's sociometric status (Denham, McKinley, Couchoud & Holt, 1990; Hartup, Glazer & Charlesworth, 1967; Masters & Furman, 1981). Popular children display on average higher levels of sociability and cognitive abilities, and lower levels of aggressive and withdrawal behaviors, while rejected children are more prompt to behave aggressively, or to withdrawal from interactions, and are also less sociable and cognitively skilled (Newcomb, Bukowski & Pattee, 1993).

The second family of measurement – profiles of behavioral and psychological attributes – is derived from the results of two Q-sets: (a) CCQ – California Child Q-sort (Block & Block, 1980); and (b) PQ – Preschool Q-sort (Bronson's adaptation of a Q-sort originally used by Baumrind, 1967). Q-sorts measures of social competence are based on the work of Block and Block (1980) on the constructs of ego-control (i.e., the inhibition of impulses) and ego-resiliency (i.e., ability to modify the level of ego-control in response to situational demands; Block & Block, 1980; Letzringa, Block & Funder, 2005). In general, Q-sorts social competence criterion reflects the child's ability to establish and maintain positive social interactions, the aptitude to deal with stress and behavioral autonomy.

Last, the third measurement family – peer acceptance – is assessed from two sociometric measures: (a) peer nominations task (McCandless & Marshall, 1957); and (b) paired comparison task (Vaughn, 2001; Vaughn, Colvin, Azria, Caya & Krzysik, 2001; Vaughn & Waters, 1981). Because most social competence definitions agree that one of the characteristics of social competent children is the ability to establish effective relationships with peers, sociometric acceptance (i.e., popularity) is considered a good indicator of social competence (Rose-Krasnor, 1997; Waters & Sroufe, 1983), and of later social adjustment (Kupersmidt, Coie & Dodge, 1990; Parker & Asher, 1987). Correlations of sociometric measures with other correlates of social competence have been widely reported. For example, social withdrawn children receive fewer positive sociometric choices or high numbers of negative sociometric choices (Harrist, Zaia, Bates, Dodge & Pettit, 1997). Aggressive and prosocial children also receive respectively high rates of negative sociometric choices or high rates of positive choices (Denham & Holt, 1993; Ladd, Price & Hart 1988; Salmivalli, Kaukiainen & Lagerspetz, 2000).

The convergence of all these broadband measures in several studies agrees with the notion of social competence as a latent trait that reflects the quality of the child's social adaptation (Peceguina, 2010; Shin et al., in press; Vaughn et al., 2009; Waters & Sroufe, 1983).

Because social competence is an individual characteristic that reflects how successfully children coordinate their interactions with their peers, it should be related with children's embedding in the preschool peer group structure. The study of social competence stems from the tradition of child and clinical psychology and tends to focus on the individual child, paying less attention to the structural features of the stable groups within which social exchanges take place. These structural features of children's peer groups both afford and constrain behavior development (Vaughn & Santos, 2009). Kummer (1968, 1971) and Crook (1970a, 1970b) were among the first ethologists to believe that differences in individual adaptation are mediated by the social structure of the group. According to this perspective, using global measures of individual activity to index individual differences in social competence neglects the relevance of the peer group structure on the social development of children.

Following an early tradition of non-human primate studies, Santos, Strayer and associates identified affilitiave subgroups, in preschool classrooms, using data from physical proximity (Santos, 1990, 1993; Santos, Vaughn & Bonnet, 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008). Briefly, using hierarchical cluster analysis children can be grouped into distinct types of affiliative subgroups, based on their profiles of associations. One type refers to subgroups whose members share similar proximity profiles and also have a high degree of proximity to each other. The other, refers to subgroups whose members have similar profiles vis-à-vis other classmates but whose proximity to each other is not statistically significant. These two subgroup types are designated as *high mutual proximity* (HMP) and *low mutual proximity* (LMP), respectively. Children who are not members of either subgroup type constitute a third category, referred as *ungrouped*.

Recent findings have revealed significant within-group preferences in both HMP and LMP subgroups using measures of visual attention and sociometric choice data (Santos et al., 2000; Santos, Vaughn & Bost, 2008; see also Chapter II). But different patterns of in-group attraction across subgroups imply that the two subgroup types are functionally distinct. High mutual proximity subgroups are more likely to be made up of a great number of friends and its members interact more with each other, while LMP subgroups may not necessarily be composed of children who share friendship relationships and its members are less biased towards one another (see Chapter II).

These differences suggest distinct degrees of cohesion across subgroup types. Social exchanges within HMP subgroups can promote common interests and growing feelings of solidarity between specific peers, or, on the other hand, lead to individual competition for specific roles, decreasing common interests and in last instance lead to the collapse of the social unit (Santos, Vaughn, Strayer & Daniel, 2008). Given their greater subgroup cohesion, HMP members may play a more salient role in the social adjustment of their co-members.

The main goal of this study is to assess the extent to which individual levels of social competence can be related to the cohesion of the affiliative social units to which children belong. This study also provides a new attempt to bridge socio-ethological and child psychology traditions in the study of preschool children's social development.

Method

Participants

The overall sample consists of 247 children, 116 of them being observed in two or three consecutive years (N = 463). Children were recruited from 19 preschool classrooms in two different centers serving middle class families in the region near Lisbon, Portugal. The sample includes a total of 145 *3-year-olds* (i.e., children < 48 months of age at the start of the academic year, 70 girls, 75 boys), 145 *4-year-olds* (i.e., children between 48 and 60 months of age at the start of the academic year, 73 girls, 72 boys) and 173 *5-year-olds* (i.e., children between 60 and 72 months of age at the start of the academic year, 88 girls, 82 boys).

Measures

Social proximity, initiated interactions and visual attention. Social proximity, interaction and visual attention data were collected by teams of two observers using a focal individual sampling design. Children were observed in a randomly determined order. No child was watched twice before all children present in a given observation round were observed first. Rounds of the three types of observational data were interspersed.

For social proximity data, children were observed for a 15-s interval, at the end of which the child's nearest peer neighbor was identified. A peer who was within arm's reach (roughly 3-4 feet) and engaged in the same or a similar activity as the target child was considered the nearest neighbor of the target. If two or more children were equally close to the focal child (as often happened when children were engaged in table activities or in group time) the peer to the child's immediate right was considered as nearest neighbor. For instances in which a child was interacting verbally or physically with a peer at the end of the 15-s interval the interacting partner was considered as the nearest neighbor, even though another child might be physically closer.

For interaction data, observers watched each child present for another 15-s interval and at the end of the interval recorded identifiers for each child with whom the target interacted. Codes for the child who initiated the interaction and affective valence (*positive*, *neutral* and *negative*) of the interaction were recorded. Interactions were scored as positive if one or both children showed positive affect (e.g., smile, laugh, gesture, or vocalization indicating a positive feeling) in the context of the social exchange, unless such affect expression was accompanied by expressions of negative affect by the interactive partner. Negative scores were given if one or both children expressed negative affects (e.g., anger, distress, fear, sadness), in a facial, vocal, or gestural mode, unless these expressions were made in the context of fantasy play. All exchanges not identified as positive or negative were coded as neutral (e.g., exchanges of greetings or conversations during a meal or in the context of a school-related task that did not include the expression of affect, nonverbal exchanges that included physical contact and a reaction to contact). Scores were the total frequencies of positive, neutral, and negative interactions initiated by the target child. For the purposes of this report, only the standardized (within classrooms) rate scores (i.e., total scores divided by the number of observation rounds for which the target child was actually present in the classroom) for positive and neutral interactions initiated were retained for analysis.

In visual regard observations an observer watched a target child for a period of 6 s and recorded the identity codes for all children receiving a unit of visual regard from the observation target. No child present in the classroom was observed twice before all other peers were observed once. Total scores were the sum of visual regard units received by a given child from all peers. The total scores were converted to rates and standardized within classroom.

In each classroom, observers spent approximately 60 min on the first observation day to become familiar with the names of participating children. The numbers of observation rounds completed by different observers were equal within a given classroom (100 each for each type of observational data). Observations took about three weeks to complete.

Research assistants received training in the observation schedule prior to initiating classroom observations. Rater agreement was estimated as the alpha coefficient for individual rate scores across raters. That is, the vector of rate scores from the observations of one observer was treated as a single “item” and the standard internal consistency estimate (Cronbach’s alpha) was calculated. This estimate assesses the representativeness of scores contributed by individual observers, rather than agreement per se for the targets of one child’s behavior. Mean (± *SD*) reliability estimates were .86 (± .10) for nearest neighbor, .82 (± .14) for social attention, .76 (± .12) for neutral interactions and .63 (± .20) for positive interactions.

Sociometric acceptance. All children completed three picture sociometric tasks: (a) positive and negative nominations; (b) paired comparisons; and (c) rating scale (but only the first two were used in this study). In each task, judgments were solicited about classmates (both boys and girls). Sociometric interviews took between 30 and 45 min to complete (usually two or three 15-min sessions). If a child's attention appeared to wander, the interviewer stopped the task and continued the interview at another time.

Positive and negative sociometric scores were derived from a nominations sociometric task (McCandless & Marshall, 1957). For this task, children were presented with the array of photographs of their classmates and asked to identify a peer they *especially liked*. After making three such choices, children were asked to identify a classmate they *did not especially like* (again repeated twice). After making three positive and three negative nominations, the child was asked to return to the array and identify additional children she or he liked. Photos were turned face down as nominated until the child had made a choice for each class member in the array. In this task, every classmate received a score indicating the order in which she or he was chosen. Positive and negative choice scores were derived from the first three positive choices and the three negative choices. Average values of positive nominations were calculated by dividing the total number of positive choices received by the number of children making choices. These values were then standardized within classroom.

Sociometric acceptance was also scored from a paired comparisons task. For this task (Vaughn, 2001; Vaughn & Waters, 1981; Vaughn et al., 2001;), cards for all pairs of children in the class were presented (total number of comparisons in a given class = $N(N - 1) / 2$), with each child's photograph appearing on the left or right hand side of the stimulus cards an equal number of times. The order of presentation was such that no child was seen twice before all other children were seen once. The child was asked *which of these two children do you especially like?* for each pair. Positive acceptance scores were the total number of times a child was chosen by peers. Total scores were divided by the number of children making choices and then standardized within classroom.

Q-sort profiles. Q-sort observers worked in teams of two for each classroom, with each observer spending a minimum of 20 hr observing the children in a given classroom, in a variety of settings (e.g., meal times, small groups, free-play indoors, outdoor play, transition activities such as standing in lines or getting ready for nap time, and teacher-supervised picking up of toys). When observations were completed, each assistant described the children with both CCQ-set (100 items) and PQ-set (72 items), according to predetermined distributions of items to nine categories. The items in both Q-sorts were sorted into nine categories (1 representing the most atypical attributes and 9, the most typical attributes of the child), with a rectangular distribution. The Q-sort descriptions of each child were used to derive social competence criterion scores for each child using the criteria published by Waters et al. (1985). The Q-sort for a given child was correlated with the profile of a hypothetical child at the extreme for social competence, generated by aggregating the descriptions provided by experts on social development. The correlation between a Q-sort for a given child and the *criterion* sort for the construct becomes her or his Q-sort score for that construct. Final scores were standardized within classroom group prior to further analysis.

Previous to data collection, observers were trained in the meanings of the items. The mean (± *SD*) cross-rater agreement for the CCQ social competence criterion score was .83 (± .21), and the mean cross-rater agreement for the PQ was .71 (± .24).

Data Analysis

Affiliative subgroups. Children were assigned rows in a dyadic matrix and observed frequencies of social proximity with each peer as nearest neighbor were tabulated into columns. This produced an asymmetrical dyadic matrix (where asymmetry implies that the AB cell in the matrix may not be equal to the BA cell). This matrix was then symmetrized (rotated on its diagonal and added to itself, AB = BA). Pearson correlations provided frequency independent measures of similarity of association. The symmetric co-occurrence matrix was used to examine similarity of proximity profiles (i.e., lines of the co-occurrences matrix) for each classroom using the complete linkage hierarchical clustering algorithm.

The complete linkage algorithm separates clusters on the basis of the largest distance between any pair of objects within clusters. Numerical taxonomists (Legendre & Legendre, 1983; Sneath & Sokal, 1962) have suggested that this algorithm is useful for taxonomy problems because it tends to form tight, spherical clusters of objects/persons.

To provide a check on the integrity of the clusters, we first chose an arbitrary level of within-cluster similarity (i.e., within-cluster correlation coefficient at the conventional level of significance, $p < .05$) to identify subgroups *vs.* ungrouped cases. Second, to identify high *vs.* low mutual proximity subgroups, we split the subgroups according to the level of mutual proximity among group co-members. If the probability of proximity frequencies among members was < .001 in a χ^2 test, a subgroup was considered to show high mutual proximity (HMP). If the probability of proximity frequencies was less than .001 for any subgroup member in these tests, the subgroup was considered to be low in mutual proximity (LMP). Children whose proximity profile did not correlate with any individual or cluster profile at the $p < .05$ level were classified as ungrouped.

From the data of the children who had observations in two consecutive years (from 3 to 4, or from 4 to 5 years of age) two logistic regressions were conducted. The first, to see if children's change of subgroup type was independent of the subgroup type children belonged in the previous year. The second, to assess the extent to which subgroup dyads remain together from one year to next was independent of the subgroup type they belong, controlling for age and subgroup sex composition (*same* or *mixed*).

Social competence. Using the protocols described by Vaughn et al. (2009), social competence was operationalized with reference to three measurement families, representing three broad dimensions previously described: (a) social motivation and engagement; (b) profiles of behavioral and psychological attributes; and (c) peer acceptance. Each domain was measured using two or three indicators (as presented above). Average standardized rates of initiating positive and neutral interactions as well as visual attention received from peers were used to index social motivation and engagement. The average of CCQ and PQ standardized scores represented the scores on profile of behavioral and psychological attributes family. Last, both nominations and pair comparison standardized acceptance scores were averaged and represented each child peer acceptance.

Multilevel model. Difference of means across subgroup type, sex, and age were evaluated for the social competence variables using a multilevel model. Multilevel modeling does not require the same number of measurements for all individuals in order to obtain efficient estimates (Hox, 2002) and given that some of the children had repeated measures, this procedure allowed us to use the full sample ($N = 463$). Two level-models were created with the repeated measures at the lowest level and the individual children at the highest level. Despite the small numbers of observations for each individual (*large J, small N designs*) multilevel models are still very effective in detecting fixed effects of model predictors (de Leeuw & Meijer, 2008).

No main effects for age should be obtained because all social competence indicators were standardized within classroom, with age taking nominal values from 3 to 5 (the same value for all children in the same classroom) since classrooms grouped children of similar age grades. But it is possible that interactions between age and the other variables might be observed.

Results

For the 19 classrooms a total of 145 multi-child subgroups were identified and 37 children were ungrouped. 109 subgroups were classified as HMP, and 36 were classified as LMP. Table 1 shows the number of children that changed their subgroup type in consecutive years. Around 42 % of the children (38.77 % from age 3 to 4 and 44.66 % from age 4 to 5), for whom repeated observations were available, changed their subgroup type. This change differed according to subgroup type, *Wald* $\chi^2(2) = 45.44$, $p < .01$, with HMP children changing less of subgroup type than both LMP, $p < .01$ (16.00 times less likely to change), and ungrouped children, $p < .01$ (17.83 less likely to change). Age had no significant effect on change.

From the 156 dyads belonging to the same subgroups (124 HMP dyads and 32 LMP dyads) that were followed consecutively, only 45 (28.89 %; 41 out of 124 HMP dyads and 4 out of 32 LMP dyads) remain together in the same subgroup in the following year. A logistic regression with age, subgroup sex composition only revealed a subgroup type effect, *Wald* $\chi^2(2) = 4.31$, $p = .04$. High mutual proximity dyads were 3.41 times more likely to stay together in proceeding years. No significant effects were found for age or subgroup sex.

Differences of mean social competence across subgroup type, sex, and age were evaluated using multilevel models. Table 2 provides mean values for the global social competence measure, the tree families and the seven indicators, according to subgroup type.

First, a model with the overall social competence score (average value of the three composite families) revealed a significant main effect for subgroup type, $F(2, 449) = 5.24$, $p < .01$. Children belonging to HMP subgroups had higher scores than ungrouped children, with LMP children scoring between HMP and ungrouped children (Table 2). Pairwise comparisons distinguished HMP from both LMP and ungrouped children ($p < .01$ and $p = .04$ respectively).

When analyzed separately, results for the social motivation family showed significant effects for both subgroup type, $F(2, 441) = 8.17$, $p < .01$, and sex , $F(1, 441) = 10.47$, $p < .01$. Again, children in HMP subgroup had higher scores than the rest (Table 2). Pairwise comparisons distinguished HMP children from LMP and ungrouped children ($p < .01$). Boys had, on average, higher scores than girls for this family (boys = .20 ± .73, girls = -.21 ± .76). No significant interaction effects were found.

Table 1

Changes in Subgroup Type from 3 to 4 Years of Age and from 4 to 5 Years of Age

	3 to 4			**4 to 5**		
	HMP	**LMP**	**Ungrouped**	**HMP**	**LMP**	**Ungrouped**
HMP	39	9	2	53	12	4
LMP	11	6	2	16	1	2
Ungrouped	3	2	1	9	2	2

Note. Younger children are presented in rows.

For the behavioral and psychological attributes family, a significant effect also indicated substantial differences between subgroup types, $F(2, 393) = 3.29$, $p = .04$, again, with children in HMP subgroups scoring higher than LMP children, and these scoring higher than ungrouped children (Table 2). Pairwise comparisons only differentiated HMP from ungrouped children ($p = .02$).

For the peer acceptance family no significant effects were found.

Table 2

Individual Social Competence, Measurement Families and Respective Indicators, According to Subgroup Type

	Subgroup type (Mean)		
	HMP	**LMP**	**Ungrouped**
Social motivation and engagement	.10 (.75)	-.16 (.75)	-.50 (.69)
Social attention	.12 (.96)	-.23 (.96)	-.51 (1.00)
Positive interactions	.09 (.98)	-.11 (1.00)	-0.48 (.80)
Neutral interactions	.10 (.97)	-0.15 (.94)	-.53 (.92)
Profiles of behavioral and psychological attributes	.09 (.90)	-.08 (.83)	-.48 (.16)
CCQ	.08 (.97)	.00 (.92)	-0.61 (.93)
PQ	.10 (.96)	-.16 (.96)	-0.36 (1.06)
Peer acceptance	.05 (.84)	-.05 (.96)	-.38 (.95)
Positive nominations	.03 (.93)	.03 (1.17)	-.38 (.74)
Paired comparisons	.07 (.94)	-.12 (.94)	-.35 (1.28)
Social competence	.10 (.64)	-.10 (.66)	-.46 (.72)

Note. Standard deviations are in parentheses.

Discussion

The purpose of this study was to assess how the insertion of children in distinct types of affilitiave subgroups (i.e., high mutual proximity *vs.* low mutual proximity *vs.* ungrouped children), with distinct levels of cohesion, was related to individual levels of social competence.

The construct of social competence was analyzed using three different measurement families: (a) social motivation and engagement; (b) children's profiles of behavioral and psychological attributes; and (c) peer acceptance; each operationalized with two or three indicators. Four models were built to assess the effects of subgroup type, sex and age on the three family scores (average values of the corresponding indicators) and on a global social competence score (average value of the three families composite scores).

Overall, results showed that children belonging to more cohesive affiliative subgroups (HMP) had higher levels of social competence than children belonging to less cohesive subgroups (LMP). Ungrouped children were generally the least competent of all.

When analyzing the different families separately, the subgroup type effects were more evident in the social motivation and engagement family, with the biggest differences occurring between HMP and ungrouped children. HMP children also distinguished themselves from LMP children in this family. Low mutual proximity and ungrouped children were not statistically different from each other. Results indicate that LMP and ungrouped children engaged less with their peers then their HMP counterparts, directing fewer social interactions toward others and receiving lower rates of visual regard. More solitary children do not necessarily experience maladjustment problems, but a number of studies have indicated that children who consistently experience a low rate and quality of peer interaction during early and middle childhood seem to be at risk of later psychosocial maladaptation (Eggum et al., 2009; Gazelle & Ladd, 2003; Oh et al., 2008; Rubin, Burges, Kennedy & Stewart, 2003; Rubin, Wojslawowicz & Oh, 2008).

Differences between boys and girls were also significant for this family (i.e., social motivation and engagement). This may result from specific interaction exchanges distinguishing boys and girls. Boys are generally more physically active and their interactions are more likely to involve dominance and competitive behaviors (Bohn-Gettler et al., 2010; Fabes, Martin & Hanish, 2003; Maccoby, 1990; Maltz & Borker, 1983; Martin, Fabes, Hanish & Hollestein, 2005; Pellegrini, Long, Roseth, Bohn & Ryzin, 2007) and as consequence they may stand out more in comparison with girls' interactions, which tend to be usually less ubiquitous. Having a more "noticeable" interactive style, boys also have a greater chance of attracting peers' attention.

Differences between subgroups were also found for the behavioral and psychological attributes family, although only HMP and ungrouped children were significantly different. Q-sort measures quantify differences in how peers interact with each other. These results suggest that HMP and LMP subgroup children are mainly distinguished, not so much due to their different behavioral and psychological attributes (i.e., the way they interact), but because LMP children are less social motivated and engaged (i.e., the frequency they interact). Ungrouped children interact less often with their peers and also do it in a less competent way than HMP children.

Although HMP children had, on average, higher scores on the peer acceptance family than both LMP and ungrouped children, these differences were not statistically significant. Results from a 5-group, multinational sample (Vaughn et al., 2009), testing the generality of the multilevel factorial model of social competence for preschool children showed that the regression path estimate (i.e., factor loadings) between social competence and peer acceptance family was the lowest of the three families. Peer acceptance is concerned with differences in how peers feel toward their classmates, rather than differences in how peers act towards each other, and there are evidences showing that peer acceptance correlates with a number of other variables not necessarily related to social competence (e.g., physical attractiveness, the names of children themselves, socioeconomic status; Hartup, 1983). If peer acceptance variables were influenced by these factors this could partly explain the non-significant differences. Also, a recent exploratory factor analysis of the seven indicators of social competence, conducted with a subsample of this data (Peceguina, 2010) suggested that a two-factor structure is the best representation of the seven measures, with social motivation and engagement measures (i.e., rates of visual attention received from peers, and positive and neutral interactions initiated) and the measures from behavioral and psychological attributes domain (i.e., the two Q-sorts) combined within one factor, and peer acceptance measures (i.e., the two sociometric interviews) placed in the other.

Data from children who were followed in consecutive years indicates some degree of stability in respect to subgroup type membership. Around 60 % of children maintain their subgroup type, but most of this stability is due to HMP subgroup children. Changes in subgroup type of LMP and ungrouped children are mostly done to HMP subgroups. These results help explain the fact that HMP subgroups are more common in 5-years-old children (see Chapter II). A recent longitudinal analysis of the hierarchical model of social competence (i.e., social competence as an hierarchical structure with three subordinate factors, or measurement families, each influencing the respective indicators) revealed significant increases in social competence scores from the first to second year of participation (Shin et al., in press). These findings also agree with the idea that older children are more likely to belong to HMP subgroups and that changes in social competence are related with changes in subgroup type membership.

An interesting result was that the stability in the members that constitute HMP subgroups was much lower than the stability of the subgroup type to which children belong. About 77 % of HMP children maintained their subgroup type, but only 33 % dyads remained as co-members from one year to the next. This suggests that although social relationships are fluid there is some continuity in the organization of behavioral patterns and personal characteristics (Cairns & Cairns, 1984).

Summing, these results seem to suggest that belonging to a more cohesive subgroup may serve as buffer to maladaptive social, emotional, and social-cognitive functioning. Although we have shown that children inserted in more cohesive subgroup are on average more socially competent, at this moment we do not know how the development of social relations and social competence co-evolve. Do cohesive subgroups arise because social competent children tend to look for each other as interaction partners? Or do children became more social competent as a consequence of being part of a subgroup group where most interactions are directed to co-members?

It is difficult to separate the effects of partner selection from effects of social influence, but recently Steglich, Snijders and Pearson (2010) developed a family of statistical models that enables researchers to separate the two effects in a statistically adequate manner. To better understand the development of social competence it is necessary to study how individual outcome variables and social structure dynamically affect each other. These models can be fitted to several data points, including both changeable attributes and social relations, during one or several school years, yielding parameter estimates that can be used for making inferences about the mechanisms driving the evolution process. These new models extend earlier methods for the analysis of pure network dynamics (Snijders 2001, 2005) by allowing the inclusion of co-evolving behavioral variables (Steglich et al., 2010).

Future studies should address the above questions in more detail by collecting several data points during each school year throughout all the preschool period. It would also be interesting to compare this possible co-evolution between affiliative relationships and social competence in children that remain with most of the same peers in the three years of preschool to children that tend to change classrooms annually. Greater stability in preschool classrooms composition has recently been suggested has a possible explanation for differences found in social competence between Portuguese children – most of the children remained together in the same classrooms in consecutive year – and North-American children – classrooms were shuffled in the beginning of the school year (Peceguina, 2010). Although the social competence model followed in this study assumes that stability in peer relations is a necessary requirement for social competence development, a certain level of variability throughout the years can create new challenges (e.g., joining a new group, developing new friendships, “fighting” for previous social achievements), which, in turn, may stimulate further development.

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Chapter V

General Discussion

Observational studies of child behavior in the 1970s marked the beginning of what Gary Ladd defines as the second generation of research on children's peer relations (Ladd, 2005). Despite the advantages that observational data provide – *"rich data about children's peer behaviors and interactions, allow for fine-grained assessments of and variability in behavior over settings and time, can be used to illustrate patterns of change, and are more likely than other methods to provide opportunities to assess specific, peer-related processes directly*" (Fabes, Martin & Hanish, 2009) – research using observational methods is still scarce when compared to the majority of studies relying on children's reports (Ladd, 2005).

The consolidation of ethological methods for the study of child development, during this period, clearly contributed to the onset of this second generation. Still, most of the ethological studies that would appear in the coming years put their emphasis on the description of stable behavioral styles, neglecting important questions about how the immediate social surroundings influences behavioral development of the individual child (Santos, 1993). The emergence of social ethology, as a newer branch of (classical) ethology, focused on questions about the structure and adaptive function of social behavior did not revolutionized the research on human development that some expected.

Although written by a biologist, the research presented here is not an appraisal of the virtues of social ethology, but is instead an attempt to use a multi-method approach to provide a more detailed account of how the peer group social context influences behavioral adaptation.

Initially focused on the importance of social dominance as the central organizing dimension of early peer groups, only in the 1980's social ethologists started to tackle the relation between social dominance and affiliative behavior. The identification of affiliative structures in children's groups was initially delayed by a lack of adequate structural models for representing cohesive organizations (Santos, 1993).

We have come a long way since Strayer (1980) introduced behavioral sociometry as a potential solution to this problem. Now the difficulty is not the lack of ways for analyzing social structures, but instead, to keep up with the constant developments on the field of social network analysis. Social network analysis provides powerful tools to study peer relations but its presence in developmental research is still incipient (see Fujisawa, Kutsukake & Hasegawa, 2008, 2009; Schaefer, Light, Fabes, Hanish & Martin, 2010 for recent applications). Curiously, in Ladd's (2005) *Children's Peer Relations and Social Competence:*

A century of Progress' section on *innovations in research methods, designs, and analysis* there is no reference to social network analysis.

As an example of the rapid growth of social network analysis, a recent review (100 pages long!) on the topic of community detection in graphs presents several dozens of algorithms to identify reasonably independent compartments of a social network (Fortunato, 2010). The algorithms reviewed by Fortunato range from traditional methods, like hierarchical clustering, to methods that go by the name of "simulated annealing", "extremal optimization", "spin models", or "greedy techniques".

Recent techniques for detecting network subgroups try to identify sets of actors that share cohesive bonds with one another and that do not have cohesive bonds to other actors in the network. These methods use different criteria about the intensity of relations between individuals needed to aggregate them.

The hierarchical cluster procedures of Santos, Strayer and associates (Santos, 1990, 1993; Santos, Vaughn & Bonnet, 2000; Santos, Vaughn & Bost, 2008; Santos, Vaughn, Strayer & Daniel, 2008; Strayer & Santos, 1996) used in Chapters II and IV focus instead on the pattern of relations in which a child is involved, and aggregate children with similar patterns (i.e., *structurally equivalent*) into jointly occupied positions. Subgroups identified this way can be composed of children with no (strong) direct relations to one another but common relations to other children. These types of subgroups are ignored in cohesion based methods. The analytical frame of structural equivalence is shifted from the dyad to the social group, considering all the relations in which an individual is involved, as well as the relations in which she or he is not involved (Burt, 1978, 1980).

Results of the first empirical study contribute to the pool of research supporting the clustering approach used by Strayer, Santos and associates as a useful procedure for studying affiliative structures in preschool classrooms. Although this procedure remains valuable, experimenting different community detection algorithms in future analysis should not be completed discard (see Daniel, Santos & Peceguina, 2010 for an initial attempt), not only to see how the results of different techniques map onto each other but also to see if they highlight different aspects of affiliative structures that might be related to children social development.

The existence of different patterns of in-group attraction across subgroups not only suggests that the subgroup types are functionally distinct but also, that these subgroups are not statistical artifacts of the clustering procedure. Co-members of children in *high mutual proximity* (HMP) subgroups were more salient targets of social attention than in children belonging to *low mutual proximity* (LMP) subgroups. If we consider that social monitoring provides an indirect measure of likelihood of social learning, than co-members in HMP subgroups are more likely to be sources of social influence. Higher cohesion of HMP subgroups was also reflected in the proportion of positive and neutral interactions directed to co-members. These results, together with the stronger in-group bias for friendship sociometric choices indicate that HMP subgroups are more likely to be made of friends. The influence of subgroup stratification also indicates that for members of high and medium status subgroups a double process of propinquity/familiarity and attraction to high social acceptance may potentiate in-group sociometric choices, but not necessarily influence the distribution of interactions.

In Chapter III there was an attempt to model the influence of different social processes in the creation and development of affiliative structures in preschoolers. This is the first application of exponential random graph models (ERGMs) in the study of preschool children social networks. There are many techniques that measure different properties of networks, nodes, or of subsets of nodes. These techniques are important for describing social structures, but social behavior is complex and statistical models allow us to capture both the regularities in the processes giving rise to networks, while at the same time recognizing that there is always some amount of variability that we are unable to model (Robins, Pattison, Kalish & Lusher, 2007).

When assuming that networks are generated by stochastic processes, in which relations can be created (or ended) in ways that may be influenced by the presence or absence of other relations or individual characteristics, the presence of certain structural configurations might be an indication that certain social processes are shaping the pattern of relational ties. For example, a *star* configuration (i.e, all individuals connected to one central player) might even arise in a network where connections are established at random, although the probability for it to happen is very low. It is more reasonable to think that such pattern is more likely to arise in the presence of, for example, a preferential attraction mechanism, where individuals tend to prefer others that already have various connections.

The models presented in this chapter showed that affiliative ties between preschool children tend to be sex segregated, highly reciprocal, more likely to be directed at some specific children and with a propensity to create transitive triads. These results can be integrated with the existence of different subgroup types identified in the first empirical study. A strong reciprocity effect is in agreement, not only with the existence of HMP subgroups in itself, but also with the fact this subgroup type was identified in all classrooms, representing 75% of all subgroups. High mutual proximity subgroups could not exist without highly reciprocal relations, but transitivity effects help explain why approximately 60 % (65 / 104) of HMP subgroups have size three or higher. The fact that the transitivity is not as strong as reciprocity also agrees with the fact that mean HMP subgroup size is around three children, with subgroups of sizes higher than four being rare. The tendency for sex segregated ties is also captured in the fact that 75 % (82 / 109) of identified HMP subgroups were of the same sex.

Popularity (not in the sociometric acceptance sense, but in the sense that children differ in the number of children who prefer them as proximity partners) maybe a reflection of underlying variations in individual characteristics (Gould, 2002) that enhance the probability of a child being selected as an interaction partner (Schaefer et al., 2010). Which individual characteristics might underlie these preferences remains to be addressed in future studies. How these characteristics can co-evolve alongside the creation of new relational ties is also a very interesting question.

Triadic closure and popularity effects observed in proximity data indicate the presence of core-periphery structure in these affiliative networks, created by the conjunction of both effects. This core-periphery structure does not imply that HMP subgroups are necessarily at the center, and that LMP and ungrouped children gravitate around them. The picture is not as simple, and actually the lack o reciprocity in LMP subgroups may give these children a more central position in the sense they connect disjoint sets of individuals (Daniel, Santos, Peceguina & Silva, 2005; Santos & Daniel, 2007).

The use of ERGMs requires a constraint on the number of parameters to be estimated, called homogeneity assumption. This means that parameters that refer to the same type of configuration need to be equated. For example, it is assumed that reciprocity effects are equal for all individuals, when in reality two individuals might not have the same exact tendency to reciprocate a tie. The resulting error is consumed into the model as statistical noise (Robins et al., 2007). Parameters thus represent a general trend that may or may not reflect individual behavior.

In Chapter IV social competence was related to subgroup cohesion. Membership in HMP subgroups may provide important occasions for the development of reciprocal friendships and communalities in shared experience. On the other hand, the fact that LMP subgroup children are not so "constrained" by a cohesive subgroup may provide them the opportunity to experience differences social contexts and consequently develop strategies that allow him or her to change from a social setting to another. Results from the third empirical study indicate that HMP subgroup children had higher social competence than both LMP and ungrouped children. In this sense, the "constrain" of cohesive subgroups is generally related to positive social development.

When broken down into the three families used to define social competence – *social motivation and engagement*, children's *profiles of behavioral and psychological attributes*, and *peer acceptance* (Bost, Vaughn, Washington, Cielinski & Bradbard, 1998; Peceguina, 2010; Shin et al., in press; Vaughn, 2001; Vaughn et al., 2009;) – only for the peer acceptance family differences for subgroups types did not reach statistical significance, despite the fact that HMP children on average still scored higher than LMP children, and these higher than ungrouped children. The results for this family were somehow expected after the findings of Chapter II showing that HMP and LMP subgroups could not be distinguished in terms of subgroup status (*high*, *medium* or *low*). Peer acceptance is concerned with differences in how peers feel toward their classmates, rather than differences in how peers act towards each other. These differences are better captured in two remaining families and suggest that peer evaluation may have taken into account more than just individual interactional styles (see Hartup, 1983).

Ungrouped children were generally the least competent of all the children observed; their social competence was clearly below classroom mean. The hierarchical clusters procedures used do not include children in subgroups if they have a very unique association profile. This does not necessarily mean they do not spend time with other children, although it was suspected this to be the case. Results from Chapter IV confirmed this hypothesis. Ungrouped children (or at least most of them) are in fact peripheral classroom members with very low scores for social motivation and engagement. The fact that a significant part of these children do eventually became members of HMP subgroups seems to work in their favor. Children most likely to be at risk of developing maladaptive social, emotional, and social-cognitive functioning are probably those who remain ungrouped in consecutive years.

Results of Chapters II and IV showed that higher subgroup cohesion is related: (a) with the relative frequency children engage co-members; (b) with higher motivation to engage peers in general; and (c) to more competent specific behavioral profiles as well. At this moment we still lack the longitudinal data that would allow to study how the development of affiliative relations and social competence co-evolve. Do children select others with similar levels of social competence and as consequence creative cohesive affiliative subgroups? Or are individual levels of social competence increased by higher cohesion in affiliative subgroups. Different data points collected during each school year, throughout all the preschool period and stochastic models for network dynamics (Steglich, Snijders & Pearson, 2010) can help answer these questions.

The fact that children tend to be inserted in somewhat fluid subgroups (in terms of the “faces” that constitute them) but children in HMP subgroups, in particular, generally maintain their type of subgroup, suggests the existence of some continuity in personal characteristics and organization of behavioral patterns (Cairns & Cairns, 1984).

Another interesting avenue to pursue in future research is to go back to the study of agonistic structures and study both affiliative and dispersive structures together, given that dyadic relationships are shaped by repeated interactions between two individuals (Hinde, 1976a, 1976b). Until recently (Fujisawa et al., 2008, 2009) most previous studies have examined these two types of network structure separately, without comparing them quantitatively. Fujisawa et al.’s (2008) findings suggest that affiliative and disruptive relationships moderately overlapped. Their results rejected the possibility that prosocial children were segregated from non-affiliative children in agonistic structures and that aggressive children were segregated from non-aggressive children in the afilliative structure. They also found that excluding the children with higher centrality in the agonistic structure destabilized affiliative structures to a greater extent. This result further suggests that cohesion in affiliative structures depends on the presence of constructive management of agonistic interactions and that these agonistic interactions are not necessarily independent of affiliative interactions.

To conclude, peer group relations are complex dynamic processes that influence children social behavior. The empirical investigations presented adopted a multi-method approach to describe, model, and relate affiliative structures to the development of social competence. These findings are a small drop in the ocean of child development research but open interesting doors for future endeavors.

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