

**Distinctive Roles of Lead Users and Opinion Leaders in the Social Networks of
Schoolchildren**

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Prior research has shown that both lead users and opinion leaders may propel the diffusion of innovation. This raises the question of whether lead users and opinion leaders are positioned similarly in social networks, which we addressed using a sample of 23 school classes consisting of 537 children. Research among children is very scarce in this particular domain. Our statistical analyses based on hierarchical linear modeling reveal two general results: First, lead users among children appear to possess a variety of links between clusters. Second, opinion leaders are locally positioned within clusters of children and have many direct links.

Generating truly novel product ideas which are attractive to large market segments is one of the most significant challenges at the "fuzzy front end" of new product development. Besides tapping internal sources, companies need to identify suitable external idea generators as well as customers who are capable of propelling the adoption and diffusion of each new product. The literature on new product development (NPD) suggests several strategies to generate ideas for truly new products, including techniques such as benchmarking (Ulrich and Eppinger 2000), user observation (Leonard and Rayport 1997), analogical thinking (Srinivasan, Lovejoy, and Beach 1997; Dahl and Moreau 2002), and the lead user approach (von Hippel 1986). Among those techniques, the lead user approach has received the greatest empirical support as a driver of commercially attractive and highly novel product ideas (Franke, von Hippel, and Schreier 2006; Lilien et al. 2002; Morrison, Roberts, and von Hippel 2000; Schreier, Oberhauser, and Prügl 2007). Lead users are described as those who are ahead of an important market trend, who expect high benefits from innovating, and who will therefore be most likely to develop commercially attractive innovations (von Hippel 1986).

Lead users may be involved not only at the "fuzzy front end" but also at later stages of the NPD process, because they are also the first to test and use their self-designed prototypes (von Hippel 2005). Thus, lead users may also serve as role models for other users within social networks at very early stages of adoption and may therefore gradually migrate into the role of opinion leaders who contribute to the diffusion of their innovations (Rogers 1976; Schreier et al. 2007). Similar to lead users, opinion leaders are considered to be more innovative and creative (Childers 1986), to be more involved and more familiar with products (Chan and Misra 1990), and to have more use experience and expertise (Venkatraman 1989) than the average user. Consequently, the following question arises: Are lead users and opinion leaders merely two sides

of the same coin? Since both generating novel product ideas and diffusing innovations are determined by individual network positions (Burt 2004; Rogers 1976), the general purpose of our research is to investigate whether lead users and opinion leaders have distinctive network roles.

On the basis of prior work on lead users and opinion leaders, insights on problem solving from cognitive psychology, as well as research on creativity, network theory and innovation diffusion theory, we develop hypotheses on the distinctive social network positions of lead users and opinion leaders. In order to test our hypotheses, we apply a hierarchical linear modeling approach in an empirical study among 23 school classes with a total of 537 pupils. In particular, research investigating network characteristics of lead users and opinion leaders among children is scanty in the literature. We find that lead users and opinion leaders do have distinctive network roles. Bridging diverse local groups increases one's likelihood of being a lead user, while acting as a hub within local groups increases the likelihood of being an opinion leader. In the next section, we develop our study's conceptual underpinnings and research questions. We then develop our hypotheses, describe the method used to test them, and present our results.

THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

Interest in the children's consumer market has grown considerably in both academic literature and in the business world. McNeal (1992) identified children as representatives of three markets in one: a primary market spending its own savings or allowances; a secondary market of "influencers" of mainly parental spending; and a tertiary, future market of potential adult consumers.

Besides this market transaction perspective on children, an innovation perspective has also come to light. Children are very often inventors themselves, developing new product concepts which are relevant to many of their peers and sometimes even to adults. One example is Michael Oliveras, an 11-year-old from Brooklyn who needed to fly frequently to see his parents and thus designed a special headrest for use on airplane seats. The headrest fastens to the side of the seat so that when passengers fall asleep, their heads do not come to rest on the shoulder of the person next to them. Oliveras received an award for his invention from the National Patent Model Association (Source: New York Times, May 1, 2007). More and more firms have begun to leverage the imagination and creativity of children for new product development: Children have been developing new building models for LEGO and new computer game features for game producers (Jeppesen and Molin 2003). Acknowledging the high potential of children as inventors, the United States Patent and Trademark Office (USPTO) launched a national campaign together with the Advertising Council and the National Inventors Hall of Fame in April 2007 in order to promote innovation by children more systematically (see <http://www.uspto.gov>).

As children lack past experience and well-established cues as to the quality or functionality of products, the interpersonal exchange of information becomes extraordinarily important (Hanson and Putler 1996; Moore and Lutz 2000). This exchange of information, or word of mouth (WOM), is the most important informal means of communication between consumers (Derbaix and Vanhamme 2003). WOM networks among children may be important to innovation activities for two reasons: First, children may be involved in the product development process itself, as they possess need and use related knowledge as consumers. Second, children may also influence each other in decisions to adopt innovations.

WOM networks may place these young users at the leading edge of innovation for two reasons: First, networks provide a social framework for children in which they can excel and gain a reputation for certain abilities within their peer groups (Jeppesen and Molin 2003; Zeller et al. 2003). Second, networks provide innovative children with instant feedback as to whether their proposed ideas are "cool" and cutting-edge. Although there is a growing body of empirical research on the lead user concept, the position of lead users in their social networks has not yet been studied in depth (either in "adult" or "child" research). However, deeper insight into the social network position of lead users is crucial to gaining a better understanding of the nature and emergence of lead users. So far, research on lead users has focused on the concept itself (von Hippel 1986), its implementation in companies (Luethje and Herstatt 2004), and its empirical validation by surveying user populations in various industries (Franke et al. 2006).

Building on the work of Whyte (1954), who first conceptualized WOM, Katz and Lazarsfeld (1965) stressed the idea that opinion leaders can accelerate the diffusion of innovations. According to Gladwell (2002), 10% of people determine the adoptive behavior of the remaining 90% by WOM. Likewise, other studies emphasize the important role of opinion leaders as information distributors (Summers 1970; Valente 1996; Czepiel 1976) and the fact that the diffusion of innovations is often initiated by a relatively small segment of opinion leaders (Coulter, Feick, and Price 2002; Van den Bulte and Joshi 2007; Watts and Dodds 2007). Research shows that WOM has an important influence on decision-making processes among children (Hansen and Hansen 2005; Roedder John and Lakshmi-Ratan 1992; Spungin 2004). Although a number of studies on opinion leaders have emerged in the literature on adults, the specific role of opinion leaders within social networks among children is often overlooked

(Hansen and Hansen 2005). To gather up the threads, our study is guided by the following central research question:

Can lead users and opinion leaders among children be identified by the nature of their individual social networks? Or, in other words: Do lead users and opinion leaders among children have distinct network roles?

TRANSLATING THE NATURE OF INDIVIDUAL SOCIAL NETWORKS INTO LEAD-USER AND OPINION-LEADER ROLES

In social networks, it appears that social structures comprise clustered networks of people with various ties among them (Bandura 2001). These ties or "weak links" guarantee the flow of information across network clusters (Brown and Reingen 1987). First conceptualized by Granovetter (1973), "weak links" refer to links between certain network actors which provide them with information advantages. Since then, Burt (1992), Freeman (1979) and others have attempted to identify and characterize the weak links connecting these clusters in networks. In the most prominent and best suited conceptualization of this structural configuration, Freeman (1979) developed the concept of "betweenness centrality." Betweenness centrality can be defined as the number of times that an actor needs a given actor in order to reach another actor or to be reached by that actor. More precisely, it is the number of shortest paths (between all pairs of actors) that pass through a given actor in a network. This kind of centrality is not based on the number of ties, but on the extent to which an actor facilitates the flow of information by being positioned on many information paths. If an actor with high betweenness centrality is removed from the network, the speed and certainty of transmission from one arbitrary point to another are

damaged more than in cases where an actor with low betweenness centrality is removed (Borgatti 1995).

In addition to betweenness centrality, two other measures are commonly conceptualized in network analysis: degree centrality and closeness centrality (Borgatti 1995). The degree centrality of an actor is simply the number of people with whom s/he has contact, corrected for the total number of people in a given network. Suppose the probability of adopting an innovation or influencing its adoption is a function of the number of people with whom an actor is in contact. We can then interpret degree centrality as a measure of an actor's "risk" of diffusing or receiving whatever information flows through the network.

The third measure is closeness centrality, which may be defined as a given actor's total graph-theoretic distance from all other actors. More precisely, closeness centrality is an index of the expected time it will take the information to flow through the network in order to reach a given actor. For example, suppose that new information enters a network at actor p , and that it takes one unit of time to traverse each link. If we assume that the information will always travel along the shortest possible route, it will reach actor q in d_{pq} units of time, where d_{pq} is the number of links in the shortest path from p to q . Admittedly, information does not always take the shortest path to specific actors. However, the length of the shortest path between two actors is highly correlated with the average length of all paths between the actors in a social network (Borgatti 1995). If the new information is equally likely to follow each possible path, closeness will usually not be far off the mark.

The Network Role of Lead Users

Lead users are on the leading edge of an important market trend and have been shown to develop radically new product concepts and solutions (Lettl, Gemuenden, and Hienerth 2008; Lilien et al. 2002). The main incentive of lead users to innovate is to find appropriate solutions for their needs (von Hippel 1986). Lead users tend to combine and reassemble any type of prior technological knowledge which brings about a solution best suited to their needs (von Hippel 2005). Insights into archetypal lead user innovations, such as the first device for gas chromatography, the first surgical navigation systems, the first medical robot for neurosurgery, the first biocompatible implant for hernia surgery (Lettl et al. 2008), and the first mountain bike (Luethje, Herstatt, and von Hippel 2005), reveal that the lead user inventor combined diverse fields of technological knowledge in each case. This is consistent with research from cognitive psychology which emphasizes the combination of diverse knowledge bases as a driver of truly innovative thought and radically new concepts (Dahl and Moreau 2002; Ward 1994).

From a social network theory standpoint, Burt (1992) argues that information access and control advantages are created when relations bridge groups, which does not necessarily indicate a large number of direct contacts. Actors with a social network bridging different groups tend to monitor information more effectively and to receive information more quickly (Staber 2004). As Burt (2004) suggests, people positioned near the "holes" in a social structure have a higher probability of coming up with good ideas. The argument is that opinions and behavior are more homogenous within groups than between groups, so people connected across groups are more familiar with alternative ways of thinking and behaving. This gives them more options to select, interpret, and synthesize. In addition, people whose networks span multiple groups have an

advantage in detecting and exploiting rewarding opportunities. Their advantage is information arbitrage. They are able to see early and more broadly (Burt 2004).

The link between the crossing of group boundaries and lead userness may also be viewed from the perspective of "sticky" information, that is, the idea that knowledge emerging from practice in groups tends to be tacit in nature and thus difficult and costly to transfer (von Hippel 1998). Individuals positioned at the intersections between distant groups have exclusive access to a variety of sticky information sources. This quality has been emphasized by von Hippel (1986, 2005) as a crucial prerequisite for developing leading-edge status. The argument is that individuals with access to diverse sources of sticky information are in a superior position to overcome an effect known as functional fixedness, a phenomenon in which real-world experience in a particular product class induces individuals to develop schemata about product features, design and usage, which in turn heavily constrains their capability to develop substantial innovations within that product class (Adamson 1952; Birch and Rabinowitz 1951).

H1: The higher the betweenness centrality of a child in his/her social network, the more likely the child can be identified as a lead user.

The Network Role of Opinion Leaders

Rogers (1976) and Coleman, Katz, and Menzel (1966) argue that informal social networks provide a better map for successful diffusion than formal communication networks. Within

social networks, certain roles accelerate the diffusion of innovation more than others. In this context, no other role has been paid more attention than that of opinion leaders.

Flynn, Goldsmith, and Eastman (1996) define opinion leaders as people who directly influence other consumers by giving advice and verbal directions for the search, purchase, and use of a product. Research evidence at the small-group level of analysis indicates that being central in social networks is a significant source of influence (Brass and Burkhardt 1992). As Barabasi and Bonabeau (2003) point out, hubs are likely to play a crucial role in the diffusion of innovation because they occupy a central position in a specific network. Network hubs refer to those actors in a network who have more contacts than others (Barabasi and Bonabeau 2003). These hubs may be regarded as the translation of opinion leadership into a network role, as opinion leadership is generally associated with a high average number of network connections (Valente 1996).

Information is most influential through direct and strong contacts (Brown and Reingen 1987; Weimann 1982). It is plausible to assume that individuals trust those to whom they have direct connections. Goldenberg et al. (2008) state that these trust relationships are closely related to the concept of homophily, that is, the idea that the people an individual gets to know are primarily a function of similarity. Researchers have studied homophily in relationships that range from close ties such as marriage (Kalmijn 2003) to professional relationships (Marsden 1988). Once such informal patterns have been established among actors who share certain similarities, the resulting networks are characterized by high stability (Feld 1997; McPherson, Smith-Lovin, and Cook 2001). Those strong contacts enable the mutual development of local orientation and coding schemes (Wilensky 1967), which in turn make it possible to transfer contextual cues to purely product-related information. Such contextual cues are inevitably necessary in order to exert a

normative or informative influence. Building upon the influential nature of opinion leaders, we expect them to exhibit high popularity within groups characterized by many direct contacts, as reflected in high degree centrality.

H2: The higher the degree centrality of a child in his/her social network, the more likely the child can be identified as an opinion leader.

It is reasonable to assume that there may be more than one opinion-leading individual within a group. As Weimann (1994) points out, opinion leaders tend to be interconnected, thus creating a powerful "invisible college" that determines the adoption or rejection of innovations. When opinion leaders possess many direct contacts and are also mutually interconnected, they are considered "close" to all other group members. Hence, we expect opinion leaders not only to show high degree centrality, but also high closeness centrality.

H3: The higher the closeness centrality of a child in his/her social network, the more likely the child can be identified as an opinion leader.

RESEARCH DESIGN

Study Design, Procedure, and Participants

In order to address our hypotheses empirically, we gathered data from nine randomly selected public schools in the Netherlands. Within the schools, we surveyed 23 classes comprising a total of 537 pupils. Jean Piaget (1971) developed a cognitive development model with four successive stages: the sensory motor period (0–2 years), pre-operational stage (2–7 years), concrete operational stage (7–11 years), and formal operational stage (11–15 years). Piaget (1971) emphasized the age of seven as a major cognitive turning point: Around this age, children make the transition from the pre-operational stage to the concrete operational stage. This implies that children around this age become better at logical, systematic thought using multiple pieces of information. In addition, language skills develop and children learn about classifications. Roedder John (1999) summarizes 25 years of research on the cognitive development of children by extracting three major phases: the perceptual stage (3-7 years), in which children are still egocentrically oriented; the analytical stage (7 to 11 years), in which children develop a social perspective; and the reflective stage (11 to 16 years). We decided to select children from pupils in three grades, basing our study on the cognitive and social development of children as suggested by Piaget (1971) and Roedder John (1999). We used a cluster sample which included children in grade 5 (approx. eight years old), grade 6 (approx. nine years old), and grade 7 (approx. 10 years old), attempting to cover children from a minimum age of seven to a maximum age of 11. In reality, the school classes also contained a small minority of children aged 12 or older, as some pupils had stayed back a year or more. Including these pupils in the sample did

not have any effects on the results; in fact, it even enhanced the robustness of the network calculations, which are very sensitive to missing data. Moreover, in order to collect data about social networks which are not ego-centered (Wassermann and Faust 1994), it is necessary to define the boundaries of the networks. As children spend a large part of their day at school (around six to eight hours per day in the Netherlands), we investigated full networks of school classes as suggested earlier (Defares et al. 1971). The full network of a school class represents a matrix which includes all indications of contacts between all children within one class. The overall sample contained 537 children in 23 school classes, with eight classes from grade 5, six classes from grade 6, and nine classes from grade 7. The average size of the school classes was around 23 pupils. The research was approved in the university's human subject approval process.

Data Collection

Collecting data from children using questionnaires is difficult because their interpretations of questions and definitions are often ambiguous. A child's cognitive, communicative and social skills undergo a process of development as s/he grows older, and this affects a child's ability to answer survey questions (Borgers 2003). In order to collect data about children's social networks, we used the Syracuse-Amsterdam-Groningen Sociometric Scale (SAGS). This method is appropriate for collecting data which covers full networks of school classes. The children were asked to complete a matrix in which the rows showed the names of all classmates and the columns indicated their frequency of contact. The children thus indicated how frequently they had contact with each of their classmates. The frequencies range from "never" to "very often" on a Likert-type scale. In order to ensure that it was easily understandable for children, the matrix

used symbols (for more detail see appendix) and one researcher was always present to explain the scale and to answer questions. With the exception of this special design for children, the SAGS instrument measures full social networks in a way similar to the scales used for adults; for example, Cohen and Cohen (1991) use a similar measurement instrument to compare networks of children and innovation teams. SAGS has the advantage of being a reliable and valid instrument for examining networks of (young) children (Defares et al. 1971; Borgers 2003).

The questionnaire also contained questions on socio-structural items such as gender and age, and batteries of items to measure lead usersness and opinion leadership. The questionnaire was completed by 519 children, meaning that the response rate in our study was around 97%. The questionnaire was designed according to the expert appraisal coding schedule for questionnaires for children and adolescents (Borgers 2003).

The item batteries used to identify the extent to which the children are lead users and opinion leaders are derived from earlier studies. However, a number of items had to be omitted because they were not suited to the cognitive capabilities of children, for example items about the monetary value of products (Chaplin and Roedder John 2007). For the same reason, we also had to minimize the number of items in the questionnaire. A pre-test among 45 children during the CineKid FilmFestival 2006 in Amsterdam confirmed our selection of items. The children understood and were able to distinguish the items we ultimately included in the questionnaire.

Measures

Measuring the Children's Social Networks. The data gathered using the SAGS instrument resulted in a matrix showing the frequency of contact between all of the children in each class.

The original 23 matrices are asymmetric, containing indications of contact frequencies between all i 's and j 's (labeled out-links) and all j 's and i 's (labeled in-links). Phrased differently, in-links are the indications about contact frequency to all other classmates of every child within one particular class, and contrary out-links the same indications of all other classmates. In some cases, the distinction between these link types is particularly important because they cannot be interpreted in the same way. In our study, however, there is no meaningful distinction between in-links and out-links, as two connected children communicate regardless of which one sends or receives the information. We also performed the analyses separately for in-links and out-links and found no differences in the results. In addition, the reciprocity of in-link and out-link indications in all school classes was higher than .70 and statistically significant ($\alpha < .001$). We thus decided to symmetrize the matrices, a step which also served to increase the robustness of the data. The analyses presented are based on the symmetrized matrices of all 23 school classes.

Betweenness Centrality. Betweenness centrality refers to the probability that communication from actor j to actor k will take a particular route. In this context, we assumed that the lines have equal weight and communication will take the shortest routes, meaning that such communication will follow one of the geodesics (Wasserman and Faust 1994). In more precise terms, betweenness centrality is defined as **(1)**

$$b_k = \sum_{ij} \frac{g_{ikj}}{g_{ij}}$$

where g_{ij} is the number of shortest paths from actor i to node j , and g_{ikj} is the number of shortest paths from i to j which pass through k . The purpose of the denominator is to provide a weighting

system so that node k is only given a full centrality point when it lies on the only shortest path between i and j . If there is another equally short path that k is not on, k is assigned only half a point based on the theory that the path that includes k only has a .50 chance of being chosen. Thus, betweenness centrality does not refer to an actor's number of direct contacts, but to the number of shortest paths which include that actor. This measure, which was proposed by Freeman (1979), is calculated using UCINET VI (Borgatti, Everett, and Freeman 2002).

Degree Centrality. Degree centrality is based on the number of units directly connected to the unit under scrutiny. The definition of actor centrality is that the most central actor must be the most active, meaning that the actor has the largest number of direct ties to other actors in the network (Freeman 1979). In this way, degree centrality measures the balance between having a peripheral position (i.e., a small number of direct contacts) and having a central position (i.e., a large number of direct contacts). This measure focuses on the level of internal communication activity within the school classes. Degree centrality may be defined as the number of ties a given node has. More precisely, the degree centrality of node i is given by (2)

$$d_i = \sum_j a_{ij}$$

where a_{ij} is the number of contacts from i to j . The degree centrality of each child is calculated using UCINET VI (Borgatti et al. 2002). Among the proposed measures of positional centrality, degree centrality is the simplest and most straightforward (Zemljič and Hlebec 2005).

Closeness Centrality. Closeness centrality can be defined as a given node's total graph-theoretic distance from all other nodes. More precisely, (3)

$$c_i = \sum_j d_{ij}$$

where d_{ij} is the number of links in the shortest path from actor i to actor j . Closeness is an inverse measure of centrality in that a larger value indicates a less central actor, while a smaller value indicates a more central actor. For the sake of simplicity and comparability, we reversed the scale direction after calculating the individual values. This measure, which was likewise proposed by Freeman (1979), is calculated using UCINET VI (Borgatti et al. 2002).

A typical interaction matrix of one class is illustrated using a sociogram in figure 1. The sociogram shows that certain children score higher in betweenness centrality (e.g., numbers 10 and 22, in dark gray) because they are connected to a variety of other children who belong to different sub-groups, whereas other children (e.g., number 20, in black) exhibit greater degree centrality. Number 20 has many contacts, but they are mainly within his/her own sub-group. At the same time, certain children are situated on the extreme periphery (e.g., numbers 15, 21, and 23, in white).

 Insert figure 1 about here

Lead Userness. Our measure reflects the idea that lead userness is considered to be domain-specific (von Hippel 1986, 2005). It consists of six indicators derived from existing scales of the lead user construct (Franke et al. 2006; Morrison et al. 2000; Morrison, Roberts, and Midgley

2004) and measured on a Likert-type scale of 1 to 5 (see appendix). The indicators refer to the characteristics of lead users as suggested by von Hippel (1986), that is, trend leadership (items 3 and 6) and high expected benefit from an innovation (items 1, 4, and 5). It has been argued that lead users are more likely to innovate than other users (von Hippel 1986). We therefore also included an indicator to cover this aspect (item 2). The scale achieved a Cronbach's alpha of .82, which implies that internal consistency was high enough to combine the indicators into a single measure of lead userness. Confirmatory factor analysis (CFA) was employed to assess measurement quality and showed a good overall fit (GFI = .96; IFI = .96; CFI = .94). All indicators loaded positively and statistically significantly on lead userness ($p < .01$), which confirms a sound level of convergent validity.

Opinion Leadership. Our opinion leadership measure also reflects the idea that opinion leadership is considered to be domain-specific (Engel, Blackwell, and Miniard 1990). This measure consists of three indicators measured on a Likert-type scale of one to five (see appendix). The first two indicators measure the communicator role and influential character of opinion leaders. These characteristics have been conceptualized and operationalized in a long tradition of measuring opinion leadership (Flynn, Goldsmith, and Eastman 1994, 1996; King and Summers 1970; Rogers and Cartano 1962). The third item refers to the high involvement and expertise of opinion leaders in a specific product class (Coulter et al. 2002; Flynn et al. 1994, 1996; Goldenberg et al. 2008; Myers and Robertson 1972; Venkatraman 1989). Knowledgeable and influential consumers have also been conceptualized and operationalized as "market mavens" (Feick and Price, 1987). We incorporated all three characteristics of opinion leadership into a concise three-indicator scale for children. A Cronbach's alpha of .79 showed that the

internal consistency of the three indicators was sufficiently high. Therefore, the indicators were combined into a single scale for opinion leadership. Confirmatory factor analysis (CFA) revealed a good overall fit (GFI = .93; IFI = .93; CFI = .92). In addition, all three indicators loaded positively and statistically significantly on opinion leadership ($p < .01$), thus pointing to a satisfactory level of convergent validity.

Self-reported measures are often criticized in the literature on adults, mainly with the argument that some people are unable to report their performance accurately due to poor introspection (Locke, Latham, and Erez 1988). However, there are also many studies which use self-reported measures and achieve high levels of accuracy (Cooper 1981). In addition, there are concepts that can hardly be measured objectively, for example "individual creativity" (Leenders, van Engelen, and Kratzer 2007). This is also the case with the concepts of lead usersness and opinion leadership. Throughout the literature, the measurement of lead usersness and opinion leadership is widely based on self-reported values. We thus adapted our measurements to existing operationalizations and used self-reported values. Moreover, there is evidence that self-ratings correlate highly with more "objective" measures in cases where anonymity is assured. In particular, Heneman (1974) found that self-reported measures were less restricted in range and leniency than the purportedly more objective ratings. Accordingly, we also promised anonymity in our study. In addition, Corey (1971) and Tittle and Hill (1967) argue that the error arising from self-reporting techniques is minor. In fact, our results enable a clear classification along the dimensions of lead usersness and opinion leadership. As shown below, we also find roughly the same association between lead usersness and opinion leadership (table 1; $r = 0.34$) as that reported in prior studies on adults (Morrison et al. 2000; Schreier et. al. 2007).

Control Variables. There are many other factors which have been shown to influence (or which may influence) behavioral effects within social networks. While it is not possible to include all other variables in this study, we chose to include two variables that have demonstrated the most prominent effect on the social networks of children. First, we included gender because males and females express and satisfy their needs and feelings differently (Del Vecchio 2002). In addition, Kalmijn (2003) reports that gender influences social networks because females are likely to have more frequent contact with friends than males do. This variable is included as a dummy, where male = 0 and female = 1. Second, we included age because children of different ages have differing likes and dislikes, and because children's thoughts, expectations, and feelings change as they grow older (Roedder John and Lakshmi-Ratan 1992). In addition, research shows that social networks are not stable over time. Stages in the course of an actor's life will also influence his/her social networks (Kalmijn 2003).

Analytical Techniques

In order to test hypotheses 1 and 2, we used hierarchical linear modeling (HLM). This method has its origins in research at schools, which are also the setting of this study, but many organizational phenomena (e.g., the behavior of individuals within teams) also occur as hierarchically ordered systems, with variables of interest residing at different levels of analysis (Hoffman, Griffin, and Gavin 2000). HLM methodology is particularly well suited for analyzing hierarchically nested data structures where micro-level observations (i.e., individuals) are nested within macro-level observations (i.e., school classes/teams; Bryk and Raudenbush 1992).

Hierarchical linear modeling explicitly recognizes that individuals within school classes/teams may be more similar to each other than to individuals in other school classes/teams and therefore may not provide independent observations (Hoffman et al. 2000). In order to test whether the observations are indeed nested in school classes, we calculated the intra-class correlation coefficients (ICCs) for lead usership and opinion leadership. The results show a moderate ICC for lead usership (.64) and opinion leadership (.72) (Shrout and Fleiss 1979). These moderate ICC scores justify the use of hierarchical linear models. For nested data, HLM analysis is not only more accurate but is in fact preferred to other approaches (e.g., OLS estimation) which do not estimate variance separately at the individual and group levels (Sarin and McDermott 2003). In HLM, the lower-level analysis is also referred to as Level 1, while the higher-level analysis is referred to as Level 2. In our analyses, Level 1 refers to the children and Level 2 refers to the 23 school classes. At Level 1, we include two dependent variables (lead usership and opinion leadership), three independent variables (individual network coefficients: betweenness, degree and closeness centrality), and two controls (age and gender). The Level 1 variables in an HLM model will allow us to determine a simple Level 2 variation. In other words, we can determine whether or not the results vary among the 23 school classes.

However, the individual network measures depend on the total number of ties within each of the 23 school classes. Therefore, we introduce network density as a measure to correct for this effect at Level 2. In a network matrix, density (D_M) is defined as the ratio of the actual number of ties to the maximum possible number which could arise. The resulting network coefficient of D_M is then the sum of all ties, z_{ij} , divided by the maximum possible number of ties, $n(n-1)$. In the example in figure 2, the maximum possible number of ties is 90, the number of observed ties is 16, and the resulting density is 0.18. Since all 23 school classes studied have an approximate size

of 23, there is no need to standardize this measure (or the individual network measures) in order to account for different group sizes.

$$D_M = \sum_{i=1}^Z \sum_{j=i-1}^Z \frac{z_{ij}}{n(n-1)}$$

In the HLM analyses, the variables were not centered as suggested by Paccagnella (2006), because we are mainly interested in the individual effects and not in the cross-level effects, which we regard as controls for our results. We verified the suitability of HLM analysis by testing for multicollinearity and the distribution of residuals. These examinations did not reveal any violations which would preclude the use of HLM analysis. However, when reviewing the distribution of the variables, we found that betweenness centrality was moderately skewed to the right, so we transformed this variable using the natural logarithm in order to achieve a normal distribution.

In order to test hypotheses 1 and 2, we regressed lead usersness and opinion leadership including betweenness, degree and closeness centrality as explanatory variables, while controlling for age and gender at Level 1 and for density at Level 2.

$$\text{Lead usersness} = \text{Constant} + b_1 \times \text{age} + b_2 \times \text{gender} + b_3 \times \text{degree c.} + b_4 \times \text{closeness c.} + b_5 \times \text{betweenness c.} + b_6 \times \text{density}$$

$$\text{Opinion leadership} = \text{Constant} + b_1 \times \text{age} + b_2 \times \text{gender} + b_3 \times \text{degree c.} + b_4 \times \text{closeness c.} + b_5 \times \text{betweenness c.} + b_6 \times \text{density}$$

Table 1 summarizes the descriptive statistics and correlation coefficients of all variables at Level 1. The variable at Level 2 (density) has a M of 0.21 and a SD of 0.05.

Insert table 1 about here

RESULTS

Correlations

Table 1 shows that lead usersness correlates positively with opinion leadership, gender, and age, as well as degree, closeness, and betweenness centrality. Therefore, lead usersness and opinion leadership are apparently not two entirely independent concepts of customer roles, as the two variables show a slight correlation (.34). Opinion leadership correlates negatively with gender and positively with age as well as degree, closeness, and betweenness centrality. Gender correlates negatively with age and closeness centrality. The correlation between gender and age is rather weak, but it does show a larger number of girls in the older school classes. While girls and boys in grade 5 are rather evenly distributed (girls 51%, boys 49%), the percentages become increasingly uneven in higher grades (grade 6: girls 53%, boys 47%; grade 7: girls 54%, boys 46%).

The age variable correlates positively with all three individual network measures. This result may imply that older ages are accompanied by a certain development in social positioning. The three centrality measures show statistically significant and positive correlations. All of the correlations mentioned are statistically significant, but their values are only low to medium high, with the exception of two correlation coefficients: Lead usership exhibits a correlation of .61 with betweenness centrality, and opinion leadership shows a correlation of .59 with degree centrality.

Testing Hypothesis 1

The HLM models 1 and 2 shown in table 2 reveal that the controls for gender and age do not affect lead usership. Therefore, neither age nor gender can be said to characterize lead users among children. The HLM analyses in models 1 and 2 also show that density has no traceable effect on the outcomes, nor can a level 2 variation be found across the 23 school classes. When the three centrality measures are entered in model 2, explained variance and model fit show a statistically significant increase from 6% to 38%. In model 2, only betweenness centrality is positively related to lead usership at a statistically significant level, and neither degree centrality nor closeness centrality affects lead usership.

Table 2Multilevel regression: Lead usersness^{a,b}

	Model 1	Model 2
Age (<i>n</i> = 519)	.20 (.13)	.14 (.09)
Gender (<i>n</i> = 519)	-.25 (.19)	-.35 (.26)
Degree c. (<i>n</i> = 519)		.05 (.04)
Closeness c. (<i>n</i> = 519)		.11 (.07)
Betweenness c. (<i>n</i> = 519)		.57 (.16)**
Density (<i>n</i> = 23)	.18 (.12)	.22 (.12)
Group-level variance σ^2	.45 (.36)	.37 (.23)
-2 log likelihood (sig. change)	511.96	374.01**
Explained variance (sig. change)	.06	.38**

^a. Two-tailed tests are reported; * $p < .05$, ** $p < .01$.

^b. n (L1) = 519; n (L2) = 23

Testing Hypotheses 2 and 3

In table 3, models 1 and 2 show that age has a statistically significant and positive effect on opinion leadership. Apparently opinion leadership is also related to age as well as the social and cognitive capabilities of the children. The three centrality measures are entered in model 2. As the results show, only degree centrality has a statistically significant and positive effect on opinion leadership. The coefficients of the other two centrality measures are also positive, but they are not statistically significant. The explained variance in table 3 shows a statistically significant increase from 8% in model 1 to 39% in model 2. In addition, model fit also improves statistically significantly from model 1 to model 2. Models 1 and 2 do not indicate any effects of network density, nor do they reveal any cross-level effects.

Table 3Multilevel regression: Opinion leadership^{a,b}

	Model 1	Model 2
Age (<i>n</i> = 519)	.35 (.17)*	.36 (.18)*
Gender (<i>n</i> = 519)	.15 (.13)	.19 (.14)
Degree c. (<i>n</i> = 519)		.41 (.11)**
Closeness c. (<i>n</i> = 519)		.26 (.14)
Betweenness c. (<i>n</i> = 519)		.09 (.06)
Density (<i>n</i> = 23)	.39 (.23)	.44 (.27)
Group-level variance σ^2	.62 (.41)	.54 (.37)
-2 log likelihood (sig. change)	467.96	309.22**
Explained variance (sig. change)	.08	.39**

^a. Two-tailed tests are reported; * $p < .05$, ** $p < .01$.

^b. n (L1) = 519; n (L2) = 23

Do Lead Users and Opinion Leaders Have Distinct Network Roles?

When testing the hypotheses on lead usersness and opinion leadership as shown in tables 2 and 3, we regressed the entire distribution of the underlying scales. However, the question at hand is whether the data also reveals similar differences when we focus solely on 'identified' lead users and opinion leaders using our scales. In order to investigate this issue, we selected those children who scored high on the lead usersness scale and/or the opinion leadership scale (average score: 2.0 or lower). At first glance, the selections reveal that many more children can be identified as opinion leaders ($n = 148$) than as lead users ($n = 98$). The magnitude of the overlap, which comprises 32 children, is rather small; in other words, 32.65% of children who score high on the lead user scale also score high on the opinion leader scale, and 21.63% of those who score high

on the opinion leadership scale also exhibit high values on the lead usersness scale. In the next step, we examined whether there are differences between children who can be 'identified' as lead users and opinion leaders as well as their network roles in terms of betweenness centrality and degree centrality. For those 32 children who score high on both scales, we investigated whether there is also an overlap in network roles. As our descriptive analyses show, 25 children (75%) score higher than the mean values for all children in both betweenness and degree centrality. In order to look at the differences between the groups of children who scored high on lead usersness or opinion leadership only, we executed two Mann-Whitney U tests. These tests support the results found earlier: The group of lead users scores statistically significantly higher in betweenness centrality and lower in degree centrality than the group of opinion leaders (betweenness centrality: $Z = -3.67$, $p = .000$; degree centrality: $Z = -4.23$, $p = .000$).

Highlighting the Results

In summarizing our results, we can make the following six points: First, all five central variables—lead usersness, opinion leadership, betweenness centrality, degree centrality, and closeness centrality—are positively and significantly correlated with one another. Second, the hierarchical linear models reveal that lead usersness is significantly explained by betweenness centrality, but not by degree or closeness centrality. Third, this result is reversed with respect to opinion leadership. Opinion leadership is significantly related to degree centrality, but not to betweenness or closeness centrality. These results allow us to confirm hypotheses 1 and 2, whereas hypothesis 3 cannot be verified. The lack of confirmation for hypothesis 3 might be explained by the nature of closeness centrality itself. This measure combines elements of both

betweenness centrality (as it reflects a wide range of distant contacts) and degree centrality (as it points to close embeddedness in direct contacts). Therefore, this combination in a network role does not appear to show any statistically significant effects which are not already covered by betweenness or degree centrality. Fourth, if we select only the upper tails of the lead usersness and opinion leadership scales, the distinctive patterns can be confirmed. There is only a small magnitude of overlap between children who score high on lead usersness and opinion leadership, and identified lead users score higher in terms of betweenness centrality, whereas identified opinion leaders score higher in terms of degree centrality. Fifth, the network density of the school classes investigated has no effect on the results. This may be explained by the low standard deviation of density among the 23 school classes. It appears that the density of communication among children at school is quite homogenous. Sixth, we did not find any cross-level effects in our analyses, which indicates that the effects revealed here do not vary among the 23 school classes of children investigated.

DISCUSSION AND CONCLUSIONS

In an increasingly individualized world, companies must concentrate on different types of customers and users throughout the stages of NPD, from the "fuzzy front end" to market introduction. At the front end, lead users facilitate and expedite this process with novel ideas and concepts, and are the first to use new prototypes and products within social networks. Lead user research to date has primarily focused on the market impact of lead user-generated innovations, revealing that lead users can develop breakthrough innovations with high commercial attractiveness (Franke et al. 2006; Lilien et al. 2002; Morrison et al. 2000). We study lead users

from the perspective of their social context. This angle is fruitful as individual creative processes are strongly affected by social embeddedness (Perry-Smith and Shalley 2003). As we are currently observing rapid growth in (online) user communities (von Hippel 2005), we expect this perspective to be of even greater relevance in the future.

As lead users not only develop novel concepts but also use new prototypes and products before others do, they propel the diffusion of innovations and act as opinion leaders at the same time. Lead users are likely to be recognized as role models because they are ahead of the mass market. They are often the first to tell people about new products and serve as a source to which others turn for advice. In the literature, these points are backed by studies on the characteristics of opinion leaders (Chan and Misra 1990; Childers 1986; Katz 1957; Venkatraman 1989).

The point of departure for our study was to ask whether lead users and opinion leaders occupy the same positions and roles in social networks. We investigated the question among children in 23 school classes comprising a total of 537 pupils.

The first result of our study is that lead users are positioned as boundary spanners between different social clusters or groups. This position allows individual consumers to access diverse information, knowledge, and ideas, thus facilitating the combination of different and unconnected knowledge domains. Individual consumers in this distinctive social position are therefore able to utilize outside-domain knowledge, which in turn facilitates the development of leading edge solutions. The identified network position of lead users provides insights into what enables them to depart from established problem-solving paradigms and thus to develop new-to-the-world products. This finding may also explain why and how individual consumers lose their leadership status over time, namely because their network position gradually shifts.

The second result is that children with high degree centrality, that is, with many direct contacts to others in social networks, can be identified as opinion leaders. This result is unsurprising because opinion leaders are said to influence many others in their product choices. However, the study suggests that opinion leadership among children cannot be identified on the basis of betweenness centrality, meaning that opinion leaders are only influential in very local terms. Opinion leaders can spread innovations, but many opinion leaders are necessary in order to achieve a broader reach.

The third result is that the scales of opinion leadership and lead usersness correlate with each other, thus confirming prior research (Morrison et al. 2000; Schreier et. al. 2007). However, in contrast to previous studies, our work indicates that children who can be identified as lead users and opinion leaders can be clearly differentiated according to network characteristics such as betweenness and degree centrality. Our descriptive analyses also show that there is only a small overlap between the two. Therefore, while the correlation between lead usersness and opinion leadership is found along the entire distribution of the scales used to identify them, it is of little practical relevance.

Our study may contribute to developing better ways to identify lead users, by the distinctive social network positions of individual consumers. This issue is important because the identification of lead users is the most crucial phase in studies of this type of user (Luethje and Herstatt 2004). Based on the insights from our study, one market research design for the identification of lead users could be to collect and analyze social network data from a consumer population within a certain domain. This social network approach can also be applied as a complement to other lead user identification methods such as screening, which involves surveying a user population with attention to lead user characteristics, or pyramiding, which is a

form of snowballing search based on cross-references to other lead users (von Hippel et al. 2005).

Our study also indicates that effective consumer information research may depend on the consumer's position in a social network. In addition, we also extend the discussion on consumer expertise, which has been considered a cognitive construct (Alba and Hutchinson 1987). Our research adds a social dimension to this discussion and yields insights into what might enable children to develop highly novel product concepts and solutions as lead users: access to distant groups which provide them with the required diversity of knowledge for highly creative problem solving. Prior consumer behavior research on children has focused on their knowledge, skills, attitudes, decision making, and the influencing processes that are relevant for them to function as consumers in various stages of development (Roedder John 1999). While this line of research has primarily referred to existing product offerings, research on children with respect to the behavioral aspects of innovation and its diffusion is quite rare. The study presented here makes a contribution to this important area of consumer research.

In sum we have shown that innovation diffusion theory, network theory, lead user theory, and opinion leadership theory can be integrated into a meaningful whole that is most fruitful when social networks are regarded as a skeleton that connects human beings and determines individual behavior.”

APPENDIX

Scale for measuring lead usersness



1. I think that toys should be nicer and more advanced. (1-always to 5-never)
2. I invent toys myself. (1-always to 5-never)
3. I think I can invent and improve toys better than adults. (1-always to 5-never)
4. I invent new toys thinking that I will somehow be rewarded for it. (1-always to 5-never)
5. I am normally the first to adopt new toys. (1-always to 5-never)
6. I would prefer to be the only one to have a new toy. (1-always to 5-never)

Scale for measuring opinion leadership

1. I tell my friends about new toys I have. (1-always to 5-never)
2. Before my friends buy new toys, they ask me for advice. (1-always to 5-never)
3. When new toys come out, I am the first to know about them. (1-always to 5-never)

SAGA (Syracuse-Amsterdam-Groningen-Sociometric-Scale)

When you discuss a problem with whom do you communicate? Please complete the following

list of classmates using the numbers  to .

-  Never
-  Not often
-  Sometimes
-  Often
-  Very often

Names classmates	Number
A	
B	
C	
D	
E	
F	
G	
H	
.....	

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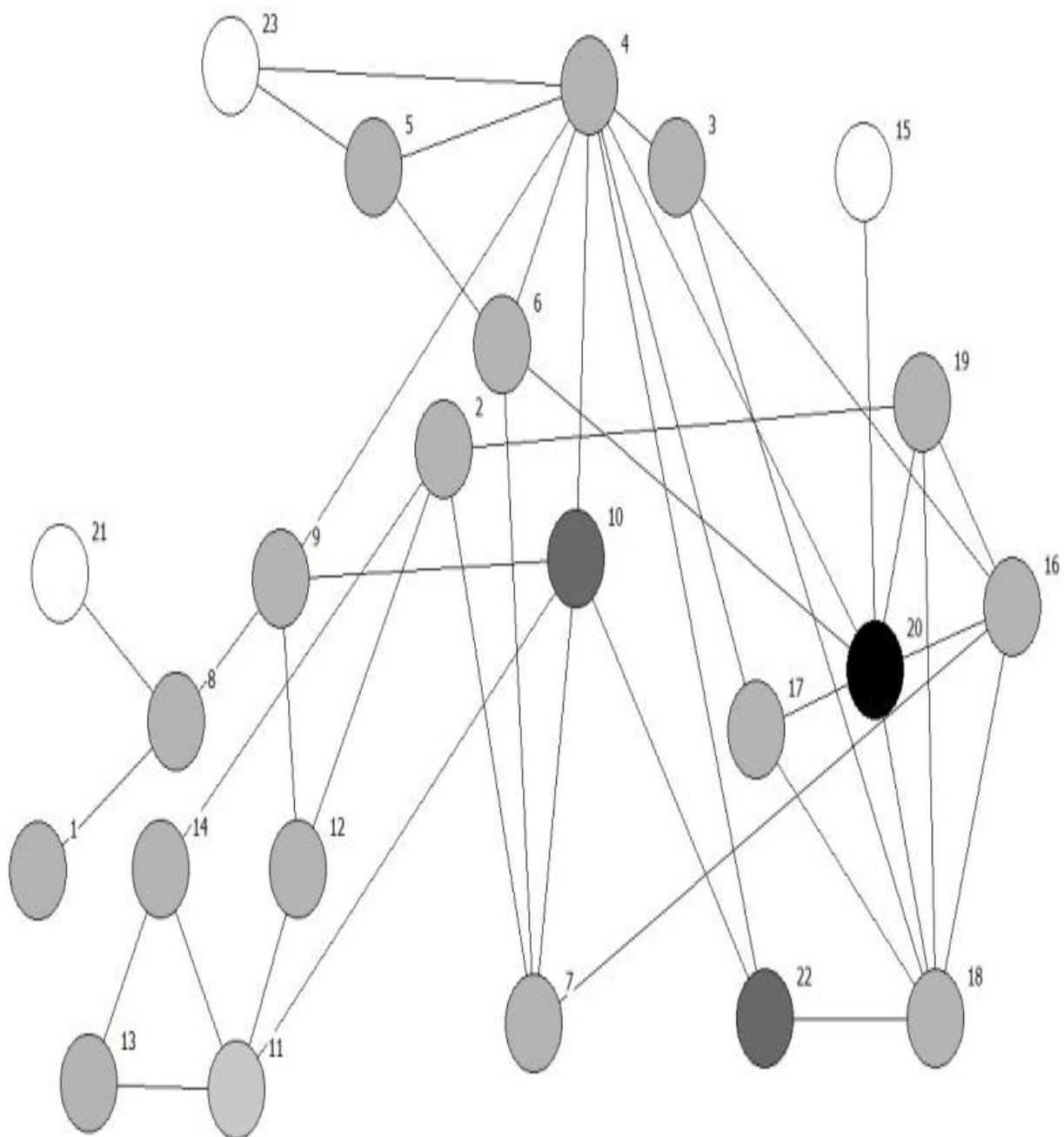
Table 1Descriptive statistics and correlation coefficients^{a,b}

Variables	<i>M</i>	<i>SD</i>	2	3	4	5	6	7
1. Lead user	3.12	.45	.34**	.17**	.25**	.09*	.23**	.61**
2. Opinion leader	2.93	.88	-	-.09*	.12*	.59**	.32**	.22**
3. Gender	.53	.51	-	-	-.11*	.02	-.09*	.06
4. Age	8.76	1.31	-	-	-	.21**	.11*	.17**
5. Degree c.	39.17	10.78	-	-	-	-	.37**	.41**
6. Closeness c.	25.60	8.33	-	-	-	-	-	.39**
7. Betweenness c.	16.30	19.75	-	-	-	-	-	-

^a. Two-tailed tests are reported; * $p < .05$, ** $p < .01$.^b. $n = 519$

Figure 1

A typical social network in a class of children



Headings List

Title: **Distinctive Roles of Lead Users and Opinion Leaders in the Social Networks of Schoolchildren**

1) THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

1) TRANSLATING THE NATURE OF INDIVIDUAL SOCIAL NETWORKS INTO LEAD-USER AND OPINION-LEADER ROLES

- 2) The Network Role of Lead Users
- 2) The Network Role of Opinion Leaders

1) RESEARCH DESIGN

- 2) Study Design, Procedure, and Participants
- 2) Data Collection
- 2) Measures
 - 3) *Measuring the Children's Social Networks*
 - 3) *Betweenness Centrality*
 - 3) *Degree Centrality*
 - 3) *Closeness Centrality*
 - 3) *Lead Userness*
 - 3) *Opinion Leadership*
 - 3) *Control Variables*
- 2) Analytical Techniques

1) RESULTS

- 2) Correlations

- 2) Testing Hypothesis 1
- 2) Testing Hypotheses 2 and 3
- 2) Do Lead Users and Opinion Leaders Have Distinct Network Roles?
- 2) Highlighting the Results

1) DISCUSSION AND CONCLUSIONS

--- APPENDIX

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