

2009

## CULTURAL DIFFERENCES IN PROSOCIAL AND SELF-EXPRESSIVE BEHAVIOUR WITH FRIENDS AND UNFAMILIAR PEERS

Rachel Lehcier-Kimel

Follow this and additional works at: <https://ir.lib.uwo.ca/digitizedtheses>

---

### Recommended Citation

Lehcier-Kimel, Rachel, "CULTURAL DIFFERENCES IN PROSOCIAL AND SELF-EXPRESSIVE BEHAVIOUR WITH FRIENDS AND UNFAMILIAR PEERS" (2009). *Digitized Theses*. 3866.  
<https://ir.lib.uwo.ca/digitizedtheses/3866>

This Thesis is brought to you for free and open access by the Digitized Special Collections at Scholarship@Western. It has been accepted for inclusion in Digitized Theses by an authorized administrator of Scholarship@Western. For more information, please contact [wlsadmin@uwo.ca](mailto:wlsadmin@uwo.ca).

CULTURAL DIFFERENCES IN PROSOCIAL AND SELF-EXPRESSIVE  
BEHAVIOUR WITH FRIENDS AND UNFAMILIAR PEERS

(Spine title: Prosocial and Self-Expressive Behaviour)

(Thesis format: Monograph)

by

Rachel Lehcier- Kimel

Graduate Program in Psychology

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Master of Science

1

School of Graduate and Postdoctoral Studies  
The University of Western Ontario  
London, Ontario, Canada

© Rachel Lehcier-Kimel 2009

## ABSTRACT

The purpose of the present study was to examine, in Chinese and Canadian children, how the context (friend, non-friends vs. mixed playmates) interacts with culture to shape the exhibition of prosocial and self-expressive behaviour in children's peer interactions. Specifically, the three main objectives of this study were to examine (1) whether there were cultural differences in the levels of prosocial and self-expressive behaviour during free play peer interactions, (2) whether the context of peers affected the specific behaviours displayed and (3) whether gender differences existed in prosocial and self-expressive behaviour demonstrated to friends, non-friends and mixed playmates in Chinese and Canadian children. Same-gender quartets of children at 11- years of age from London, Canada and Beijing, China were observed in laboratory free-play settings. The results revealed a series of main effect and interactions involving gender, culture and context. In general, regarding cultural differences, Chinese children (mainly boys in interactions with mixed playmates and girls in interactions with friend) displayed more prosocial behaviour than Canadian children. Canadian children displayed more self-expressive behaviours than Chinese children, but mainly in interactions with mixed playmates. Regarding gender differences, girls displayed more prosocial and self-expressive behaviour than boys in interactions with friend, whereas boys displayed more prosocial scores than girls in interactions with mixed playmates. The results indicate that multiple contextual and personal factors may be involved in determining individual social behaviour in peer interactions.

**Keywords:** Peer Interactions, Prosocial Behaviour, Self-Expressive Behaviour, Culture, Gender, Context.

## TABLE OF CONTENTS

	Page
Certificate of Examination.....	ii
Abstract.....	iii
Table of Contents.....	iv
List of Tables.....	v
List of Figures.....	vi
List of Appendices.....	vii
INTRODUCTION.....	1
Major Theories of Peer Interactions and Relationships.....	3
Children’s Peer Interactions.....	6
Prosocial Behavior and Self-Expressive Behaviour in Peer Interaction.....	8
Interactions with Friends and Unfamiliar Peers.....	13
Culture and Peer Interactions.....	17
Cultural Differences in Shyness-Inhibition.....	22
Culture and Social Initiative and Self-Control.....	24
Gaps in the field.....	27
Summary, Research Questions and Hypotheses.....	28
METHOD.....	32
Participants.....	32
Procedure.....	32
Coding.....	33
RESULTS.....	36
DISCUSSION.....	42
Cross-Cultural Differences in Prosocial Behavior.....	42
Cross-Cultural Differences in Expression of Opinion.....	44
Friend vs. Unfamiliar Peer: The Role of Context.....	46
Gender Differences.....	47
Conclusions, Contributions of the Study, and Limitations.....	47
REFERENCES.....	51
APPENDICES.....	63
Appendix A: Early Behavioral Characteristics, Relationships and Socio-emotional Adjustment Study: Information Letter and Consent Form.....	63
Appendix B: Lab observation of 14-year-olds Protocol.....	67
Appendix C: Friendship Interaction Coding.....	76
CURRICULUM VITAE.....	81

## LIST OF TABLES

Table	Description	Page
1	Means and Standard Deviation for the Prosocial and Self-Expressive Behaviours.....	41

## LIST OF FIGURES

Figure	Description	Page
1	Frequency scores of prosocial and self-expressive behaviours.....	40

## LIST OF APPENDICES

Table	Description	Page
A	Early Behavioral Characteristics, Relationships and Socio-emotional Adjustment Study: Information Letter and Consent Form.....	63
B	Lab observation of 14-year-olds Protocol.....	67
C	Friendship Interaction Coding.....	76

## Cultural Differences in Prosocial and Self-Expressive Behaviour with Friends and Unfamiliar Peers

Peers have been defined as nonfamily age-mates who are similar to one another in maturity and competence level (Edwards, Tretasco de Guzman, Brown & Kumru, 2006). Research indicates that compared to younger children, older youth interact with peers more frequently and for longer periods of time, both within and outside of school (Larson & Richards, 1991). Not only do older children spend more time with peers but they also attribute more importance to peer relationships than younger children (Feiring & Lewis, 1989; Berndt, Hawkins, & Jiao, 1999). Reflective of this are the findings that older children's friendships become more stable and that older children tend to possess more intimate knowledge of their friends and to see their friendships as more exclusive and individualized (Furman & Bierman, 1983; Berndt 1999). Children's descriptions of their friendships indicate that loyalty, self-disclosure and trust increase with age (Berndt, 1999). Older children's understandings of friendship also become more sophisticated in that they begin to focus not only on external factors but also on individual affective, motivational and prosocial intentions (Furman et al., 1983).

Middle childhood has been shown to be an important period in cognitive, neurological and socioemotional development. This time period is seen as a transitional period between childhood and adolescence during which children gain the skills needed to be competent members of the larger group (Edwards et al., 2006). Children's role in the socialization process becomes increasingly more active, as they are more likely to make their own choices in social interactions during middle childhood. Studies of children's friendships show that between early and middle childhood they evolve



significantly into more abstract concepts based upon mutual consideration and psychological satisfaction (Rubin, Bukowski, & Parker, 2006). The changes in friendships are likely indicative of individual developmental changes as well as social experiences. Although the specific type and frequency of peer interactions a child is exposed to vary based on the sociocultural environmental context in which they live, with age comes the increasing opportunity for children to choose the interactions they engage in. With this increasing capability for choice, individual preferences as well as behaviour patterns become evident (Edwards et al., 2006). Older children begin to exercise more influence on their environments as a result of the choices they make. During interactions with peers, children behave in ways to accept, resist or transform the activities that occur (Edwards et al., 2006).

Examination of social interactions between peers provides important insights into children's individual development, as peer interactions are associated with greater socio-cognitive abilities, emotional understanding, and social skills (Rubin et al., 2006). The literature suggests that children contribute in significant ways to each other's development. In fact, it has been suggested that peers are "necessities, not luxuries" in human development (Hartup, 2008), and contact with other children has been shown to alter the nature of a child's instrumental activity, the frequency of their ongoing behaviour and interpersonal perceptions (Brendgen, Markiewicz, Doyle, & Bukowski, 2001; Hartup, 2008). There is growing evidence that peer interaction provides children with a unique context for mastering a wide range of skills and competencies essential to adaptive functioning (Bukowski, Newcomb, & Hartup, 1996).

*Major Theories of Peer Interactions and Relationships*

George Herbert Mead proposed the theory of symbolic interactionism (1934) focusing on the connections between peer interactions and self awareness. According to symbolic interactionism, it is through the experiences of peer play and social interaction that children acquire the ability to understand the perspectives of others, and more important, themselves in other's perspectives. Mead argued that social understanding is critical to the development of the self-system. The symbolic interactionism emphasizes that children's ability to reflect on the self and to consider the self in relation to others is primarily a function of participating in organized activities with peers (Rubin, Coplan, Chen, Buskirk, & Wojslawowicz, 2005).

Jean Piaget considered the influence of peers to be critical to social-cognitive development (1932). Piaget saw peer interactions as formative in relation to the achievement of concrete operations in the early school years. According to Piaget, the pre-school child was too egocentric to be able to achieve operational thought. Since operational thought requires the ability to take into account multiple points of view as well as multiple covarying factors in a situation, pre-schoolers who tend to focus on the first factor they identify can not move beyond this 'centration' (Piaget, 1932) and onto operational thought. Piaget saw the influence of others and specifically interactions with someone else who saw things differently than oneself, as the necessary disturbance to the egocentrism of young children (Piaget, 1932). Piaget also argued that the unequal status between children and adults brought with it issues of power and authority that could not be considered separate from the effectiveness of this process. As Piaget pointed out, children's peer interactions operate in a symmetrical egalitarian context whereas adult-

child relationships are asymmetrical since children are required to obey and accept the rules and standards of behaviour set by the adults in their life. Within the egalitarian context of peer relationships, children do not have the power to compel their peers to obey them. As a result, in order to achieve goals, children must learn to express their feelings, explore conflicting ideas, engage in negotiations, and understand the perspective of others (Berndt, 1999). According to Piaget, mastery of such skills is influential in the healthy development of children's social-cognitive functioning (Berndt, 1999).

During the 1950's, behaviourists attempted to explain human behaviours in terms of learning processes (Hay, Caplan & Nash, 2008). Socialization is understood as a process in which socialization agents set out a list of socially prescribed behaviour which the child is to acquire. The laws of learning could be applied as a guide to understanding why children learn behaviour in different ways and at different speeds. The notion of reinforcement (positive and negative) is seen as the basic process whereby social behaviour is acquired (Maccoby, 2000). Children, even at young ages, are able to identify positive and negative reinforcing events in interactional sequences (Hartup, 2008). Peers have come to be seen as one of the primary agents of socialization. With peers, the child begins to broaden his or her circle of interaction to people outside of the immediate family. Since peer interaction in the early years is closely supervised by parents, it tends to reinforce what is learned in the family. However, even in these closely supervised situations, young children are exposed to the social skills required in group situations with social equals (Hay et al., 2008). As childhood progresses, peer group interactions become more autonomous. At the same time, through peer interactions

children learn basic rules of group interaction as well as more complex strategies of negotiation, dominance, leadership, cooperation and compromise (Hay et al., 2008).

Based on behaviourism, Bandura and Walters' (1963) social learning theory emphasizes the role of modeling in development. Social learning theory is centered on the importance of observing and modeling the behaviour, attitudes and emotional reactions of others. It provides a strong basis for many observational studies of children's peer interactions. Observation is central to social learning theory in that the learning of new behaviour occurs through the process of imitation of others. The implications of social learning theory are profound in that it suggests an action does not need to be performed or reinforced at the time of learning. However, Bandura did stress that once an individual learns a given behaviour through observation the probability that they will imitate the behaviour overtly, will depend on their assessment of whether the behaviour is likely to be reinforced. In other words, through the process of modeling children learn about their social environment. Whereas a child's competent and normative behaviour will be socially accepted and positively reinforced, deviant and non-normative behaviour will be socially rejected and ignored by peers (Rubin et al, 2005). Results of most empirical studies have indicated that observational tendencies are particularly strong in certain contexts such as situations involving disinhibition and vicarious reinforcement. Information on how peer observational learning manifests in everyday life, especially when a delay exists between the modeling event and the replication of behaviour by the observer, is scarce (Hartup, 2008).

*Children's Peer Interactions*

Peers are arguably one of the most important socialization agents over the life course (Waldrip, Malcolm & Jensen-Campbell, 2008). Furthermore, having close friendships in adolescence often serves to fulfill important social needs such as the need to belong and may act as a buffer against stressors in adolescence (Brendgen et al., 2001; Waldrip et al., 2008). Bukowski & Hoza (1989) identified three different friendship facets that influence developmental outcomes: number of mutual friends, participation in a best friendship, and friendship quality. Each dimension has been linked to adjustment outcomes in important ways. For example, Boulton, Trueman, Chau, Whitehead, and Amatya (1999) found that adolescents with a best friend received fewer peer nominations for victimization than adolescents without a reciprocated friendship. In addition, Hodges, Boivin, Vitaro, and Bukowski (1999) reported that having at least one reciprocal dyadic friendship protected a child from increases in internalizing and externalizing behaviours after peer-reported victimization. Therefore, adolescents who are involved in reciprocal friendships tend to be better adjusted in various domains than adolescents who do not participate in at least one reciprocal friendship (Berndt et al., 1999; Waldrip et al., 2008).

As children progress through childhood and into adolescence, they begin to shift from dependence on family members to a sense of individual independence. During this process, children often explore their developing sense of autonomy in the context of peer relationships (Brendgen et al., 2001; Feiring et al., 1991). As children mature, their relationships tend to concentrate more on friendships than family interactions. While parents still play significant roles in older children's lives, the amount of time children

spend with their parents decreases, as they spend more time with their peers (Larson & Richards, 1991; Rubin, Bukowski, & Parker, 2006; Waldrip et al., 2008).

Whereas friendships can be seen as relatively more transient and superficial in early childhood, peer relationships and friendships during middle childhood become more clearly defined and stable (Edwards et al., 2006). Within the context of peer relationships, children are able to develop a sense of mutual trust. Once this trust is established, children tend to display high levels of self-disclosure during their peer interactions (Waldrip et al., 2008). Through this process children learn important lessons about themselves, their social identity and the broader cultural world in which they live. Friendships exist as a source of felt security, social support and self-esteem. Friendships also exist as a forum for the development of social competence and for practicing later relationships (Waldrip et al., 2008). In this way, peer interactions provide an important opportunity for children to learn from others and to gain exposure to broader socio-cultural norms and values (Chen & French, 2008).

Peer interaction occurs with one child's elicitation of another child's social response (Rubin et al., 2006). Unquestionably, social initiation influences response. However, the quality of response one child makes to an initiation also influences the tendency for the initiator to direct future social behaviour (Dodge, Pettit, McClaskey & Brown, 1986). In other words, while social initiations represent a necessary condition for the beginning of social interactions, the specific type of behavioural response received from the target child, may determine whether the social interaction continues (Chen et al., 2006a). Research has consistently demonstrated that the ability to establish and maintain

positive peer interactions is important for the development of social relationships as well as for adjustment in general (Dodge et al., 1986).

### *Prosocial Behaviour and Self-Expressive Behaviour in Peer Interaction*

Peer interactions provide an important context for the study of children's social behaviour such as prosocial behaviour. Prosocial behaviour is defined as any voluntary action that produces a positive or beneficial outcome for the recipient, regardless of whether that action is costly, neutral or beneficial to the donor (Grusec, Davidov & Lundell, 2004; Eisenberg, Fabes, & Spinrad, 2006). Since prosocial behaviour is associated in significant ways with socialization practices and experiences, it is important to consider the possibility that certain cultural contexts may promote or emphasize the exhibition of prosocial behaviour more than others.

Research supports the notion that when interacting with peers, children as young as pre-school age tend to demonstrate relational concerns and behave in other-oriented ways (Fujisawa, Kutsukake, & Hasegawa, 2008). Within peer relationships, children receive reinforcement for prosocial actions through the exchange of positive responses from peers. Such positive responses from peers include smiles, approval of the behaviour, showing appreciation and continuing interaction (Fujisawa et al., 2008). Research has shown that children who exhibit positive responses to initiations of prosocial behaviour made by others frequently receive positive reinforcement from their peers for their own initiations of prosocial behaviour (Eisenberg, Cameron, Tryon, & Dodez, 1981).

Cultural differences have been noted in the ways that children are socialized as well as in the specific behaviours seen as priorities for parents to teach their children (Chen & French, 2008; Miller, 1994, Stevenson, 1991; Whiting & Edwards, 1988). For

example, China, India, Taiwan and Japan have been identified as societies that beginning in the child's earliest years of life make explicit efforts to instill and promote prosocial behaviour. From very early ages, Asian parents focus on making the child aware of the role of the individual in relation to family and society. Raising an independent child as is a priority in the West, is not a major focus for Chinese and Japanese parents who instead prioritize establishing interdependent relations between the child and other members of the family and society (Stevenson, 1991). In addition, Chinese, Indian and Japanese parents focus primarily on their child's moral development and achievement since in these cultures parents are considered to be successful if their child is seen as having a high moral conduct, demonstrating respectfulness, humility, and good manners in school (Stevenson, 1991; Best & Ruther, 1994). A major goal in Asian cultures is for all citizens to act in ways that preserve order and harmony in society. This goal also serves to drive parents' socialization efforts to instill prosocial behaviour in their children. Unlike in the West where children are typically expected to learn prosocial behaviour incidentally, purposeful and direct efforts to train children from very young ages to demonstrate such behaviour occur in Asian cultures (Best & Ruther, 1994).

Keller (2004) found that children in Western cultures are more likely to emphasize relationship intimacy whereas children in non-Western cultures are more likely to stress altruism and the necessity of moral issues in their understandings of close friendships. Fujisawa et al (2008), studied reciprocity in 3 and 4 year old Japanese children's peer interactions during free play. Their findings reinforced those of previous studies in that Japanese children were found to spontaneously show reciprocity of prosocial behaviour. Fujisawa et al., also found positive correlations between the



frequencies of object offering and object receiving within dyads (Fujisawa et al., 2008).

The findings of this study suggested that children as young as three or four may adjust the degree of reciprocity they exhibit based on friendship (Fujisawa et al., 2008).

In Western cultures, parents' desire for their children to be caring and concerned for others is often conflicting with the knowledge that help is not always desired or received well by others. Parents in Western cultures may also believe that too much concern for others may be harmful to oneself and in extreme cases that extensive concern for others may place children at risk for psychological disorders such as depression (Stevenson, 1991). Researchers have suggested that these conflicting views on prosocial behaviour are characteristics of Western cultures where social responsibility is less duty based and individualistic goals and characteristics are emphasized. Parents in Western cultures may place greater emphasis on characteristics such as competitiveness and other self-enhancing behaviour due to a belief that children who demonstrate these behaviours may experience greater social success later in life (Grusec et al., 2004).

The expression of opinions, comments and evaluations with regard to other individuals or events is common in peer interactions (Bauminger et al., 2008). Individuals are often concerned with a number of issues and outcomes that organize their thoughts, needs and goals (Bauminger, Finzi-Dottan, Chason & Har-Even, 2008), and these issues and concerns, which may be related to cognitive development, cultural pressures and life experiences (Ting-Tomey, 1991), exert a dominant and organizing influence on the self-expressive behaviour that individual demonstrates (Berndt & Hanna, 1995).

When youth share their views and opinions with others such as friends and are supported, they likely feel a sense of validation and self-worth. By expressing personal

opinions, youth are indicating that they trust their peers and feel comfortable sharing their thoughts, self-evaluations, or important past experiences (Bauminger et al., 2008). Self-expression may provide social feedback assuring an individual that he or she is not alone in his or her thoughts, feelings or experiences and in this way may be related to self-confidence (Berndt & Hanna, 1995). Self-expression is also a viable means through which individuals can express themselves and their built up thoughts and feelings in a therapeutic manner (Derlega & Grzelak, 1979). In this way, disclosers may feel a release from venting distressing information and by divulging this emotional information may also invite emotional support and problem-solving assistance (Bauminger et al., 2008; Colarossi & Eccles, 2000).

Throughout middle childhood and adolescence youth experience considerable stress (Berndt & Hanna, 1995). Given the increasing importance of peer relationships during this time, it is likely that these youth will often turn to their friends to seek support. One way in which peer relationships may afford youth the support they seek is through the process of self-expression. Researchers today widely agree that experiences with friends provide a unique context for satisfying the need for interpersonal intimacy (Hartup & Stevens, 1997; Newcomb & Bagwell, 1995; Bauminger et al., 2008; Rubin et al., 2006). Within the security of the intimate bond of friendship, children are able to share their views and opinions, and express their feelings and thoughts. Thus, friendships provide affection and opportunities for sharing (Berndt & Hanna, 1995; Berndt, 2002; Rubin et al., 2006). There is empirical support for the idea that self-expression is related to other aspects of friendship quality such as companionship, affection, help and guidance (Buhrmester & Furman, 1987; Bukowski et al., 1996; Rubin et al., 2006).

Self-expression to peers increases during adolescence while expression to parents decreases (Bauminger et al., 2008). This difference reflects the increased amount of time that older children spend with their peers as well as the increasing role of peers in terms of providing social support (Bauminger et al., 2008). In addition, as children mature through middle childhood into adolescence, concerns regarding social approval shift from parents and other adults to the peer group (Derlega & Grzelak, 1979; Bauminger et al., 2008). As a result, many youth may use self-expression to peers as a means to gain social validation of thoughts, feelings or actions from their age-mates (Ting-Tomey, 1991; Berndt & Hanna, 1995; Bauminger et al., 2008). With the increased focus on autonomy during adolescence comes an increase in behaviour directly related to the pursuit of individuality. Self-expression may be related to autonomy seeking, and serve as a tool through which children can demonstrate assertiveness and enhance their independence (Bauminger et al., 2008). In view of the research on cross-cultural differences in social-initiative and assertive behaviour this may be especially true for children from Western cultures. In the Western world, autonomy and personal choice are highly valued. Parents tend to socialize their children to become independent from the early years, and as adolescents begin to question the definitive authority and expertise of adults, peers become increasingly important as additional sources of advice and support, which impact the development of autonomy (Savin-Williams & Berndt, 1990). It has been found that young people learn to be autonomous while also maintaining valued connections to friends by expressing their opinions and attitudes (Bauminger et al., 2008). During this process, children learn that their friends' opinions may differ, negotiate differences with others, and practice joint decision-making. Thus, self-expression is a key mechanism

through which children and adolescents can both demonstrate their personal choices and thoughts to peers and receive their advice and support (Bauminger et al., 2008).

Research has demonstrated several differences in the peer interactions of boys and girls. In general, boys tend to interact in groups, while girls prefer dyadic interactions (Benenson, Apostoleris, & Parnass, 1997). Furthermore, once friendships have been established, girls tend to maintain close friendships that are more isolated and private, whereas boys tend to engage in friendships within the context of a larger social network (Benenson et al., 1997). However, the most notable gender difference in friendships is that overall girls' friendships contain higher levels of self-expression and as a result are classified as more intimate (Brendgen, Markiewicz, Doyle, & Bukowski, 2001). Boys' friendships on the other hand tend to be more "activity-oriented" (Brendgen et al., 2001). In addition, research indicates that girls' friendships tend to be more fragile and less stable than boys' friendships (Benenson & Christakos, 2003). When considering the findings on self-expression, a possible explanation for this is that when a conflict arises between friends, the occurrence of self-expression places girls in a vulnerable position and at risk of having their personal opinions shared with others they did not express it to (Benenson et al., 2003). Boys, on the other hand tend to engage in activities that do not involve the exchange of personal information or opinions and since boys' friendships most frequently occur within a larger social network, conflicts between peers may be resolved with the help of other members in the social group (Rubin et al., 2006).

#### *Interactions with Friends and Unfamiliar Peers*

During any social interaction, an individual's behaviour is determined not only by that individual's dispositional characteristics but also by his/her relationships with the

interactional partner(s). During social interactions, peer relationships may serve to regulate and direct children's behaviour (Cairns & Cairns, 1994).

Given this background, it is not surprising that peer interactions with familiar and unfamiliar peers may differ. Interactions with familiar peers, such as friends, may be considered a special type of peer interactions. Friendship is widely defined as a voluntary and reciprocal relationship, marked by mutual attraction and pleasure taken in one another's company (Rubin et al., 2006). Children's friendships are different from other peer relationships in terms of the unique contributions they make to social and personality development (Buhrmester & Furman, 1987). Friendships provide a higher degree of intimacy and affection between partners (Berndt, 1981). As a result of this higher degree of intimacy and mutual commitment, friendships provide children with a unique context for mastering a wide range of skills and competencies essential to adaptive functioning (e.g., Bukowski, Newcomb, & Hartup, 1996). Friendship is often described in terms of the frequency of positive reinforcement as well as the amount of mutual satisfaction that friends provide one another with. In accordance with this, children may be expected to share and help friends more than unfamiliar peers (Berndt, 1981).

During middle and late childhood, the prevalence of friendship is around 80% (Hartup & Stevens, 1997). This number increases in late adolescence when 80-90% of children and teenagers report having mutual friends (Hartup & Stevens, 1997). Studies examining children's friendships in different cultural contexts have shown that the prevalence of reciprocated friendships (i.e., partners nominate each other as friend) in other cultures is similar to that found in North America. For example, 80% of Canadian

children, 83% of Italian children and 80% of Indonesian children are found to experience reciprocated friendships (Schneider, Fonzi, Tani, 1997).

Peer familiarity is a variable whose potential importance in social interaction deserves investigation for several reasons. Interactions with friends are marked by greater emotional expressiveness and intensity than those with other peers or strangers (Berndt et al., 1999). Friendships provide children with a unique context for the development of important skills, such as mutual respect, competencies associated with effective interpersonal interactions (Newcomb & Bagwell, 1996), and meta-cognitive skills (Hartup, 1992). Relative to relationships with parents, as children grow older, they begin to experience higher levels of companionship and intimacy with close friends (Buhrmester & Furman, 1987). As a result of the intimate nature of a friendship, children have opportunities to practice and evaluate their social skills during interactions with friends, foster a strong sense of self-worth, and engage in interactions that promote cognitive growth (Newcomb & Bagwell, 1996). Interactions with a friend have been found to be more frequent and more complex than with an unfamiliar peer (Doyle, Connolly & Rivest, 1980). Schwarz (1972) found that in a novel situation, young children aged 4, showed more positive affect, motility and verbalization with a friend than either with a stranger or alone. Extending these findings, Lewis et al. (1975) found that very young children at 1 year of age showed more proximity, imitation, and positive interaction over toys with familiar playmates than with unfamiliar playmates (Doyle et al., 1980).

Doyle et al., (1980) raised the question of whether the interactions with toys that children engage in with familiar peers is not only more frequent and positive but also

more complex and mature than the interactions children engage in with unfamiliar peers. The only study yet to address this question was conducted by Rubinstein and Howes in 1976. Their findings suggest that the complexity of toddler's play was positively affected by the presence of a familiar versus unfamiliar peer (Doyle et al., 1980).

A meta-analysis conducted by Newcomb & Bagwell (1996), reported that interactions with friends differed significantly from interactions with less familiar peers. Interactions with friends were characterized by more intense affective and affiliative features than interactions with less familiar peers. More specifically, the research suggests that friends display greater positive affect (smiling, laughing), display more affective expressions, converse more with one another, engage in a higher frequency of physical contact, and display higher play sophistication through increased task related behaviour, talking, cooperation and self-disclosure (Newcomb & Bagwell, 1995). Friends also show more mild forms of conflict including competition, dominance, criticism, and teasing (Newcomb & Bagwell, 1995; Newcomb & Bagwell, 1996).

Therefore, current research supports the notion that friends exhibit more positive behaviour and more conflict than non-friend peers. During conflict, friends tend to resolve it more quickly and in a more positive manner (Hartup, 1997; Rubin et al., 2006). However, the magnitude of these behavioural differences in children's relationships with friends and non-friends has been shown to be small. In the Newcomb and Bagwell (1996) meta-analysis, a variety of children's behaviour with friends and non-friends were compared. Results indicate that the effect sizes of children's behaviour in observational studies are below the criteria of a small effect ( $d = .50$ ); (Rosenthal & Rosnow, 1991).

*Culture and Peer Interactions*

Culture is a critical yet often overlooked factor to consider when examining the specific types of behaviour displayed by children during peer interactions. Culture is often defined as a system of shared beliefs, values, and customs that people within a group, community, or society endorse and use to guide their social interactions and to cope with their world (Ji, Peng, & Nisbett, 2000). The cultural system is transmitted and develops from generation to generation through learning as well as continuous construction and innovation (Best et al., 1994). Cultural norms and values provide guidelines for understanding and interpreting social behaviours and thus influence the manifestations of the behaviours (Chen, DeSouza, Chen & Wang, 2006a). Cultural norms and values play a role in child development largely through children's interaction with their environment (Greenfield, Suzuki & Rothstein-Fisch, 2006). Culture shapes and organizes the environments in which children's social interactions occur, and affects the ways in which children interact with others.

Recently, social psychology has experienced a resurgence in the notion that cultural context shapes the self. Selfways are defined as communities' ideas about being a person and the social practices, situations, and institutions of everyday life that represent and foster these ideas (Markus, Mullally, & Kitayama, 1997). Selfways include core cultural ideas and values, including understandings of what a person is and a sense of how to be a good, moral or appropriate person. These ideas include practices, habits, and customs which appear as subjectively natural ways of acting and interacting with others (Markus et al., 1997).



According to Bronfenbrenner's ecological systems theory (1979), culture is a part of the social context for human development. The ecological systems theory conceptualizes child development as a result of the interactions between complex "layers" of the environment (Bronfenbrenner & Morris, 1998). Culture is likely to affect children's development through the beliefs, customs and values that are transmitted through the child's interaction with their immediate surrounding (Hinde, 1987). In addition to its direct effects, culture may regulate child development through organizing social settings such as community services and school and daycare conditions.

The sociocultural theory provides another major perspective on the effects of culture on human development (Vygotsky, 1978). This theory suggests that children learn through social interactions with other people but that learning occurs first at the social level and only afterwards at the individual level (Vygotsky, 1978). The process of guided learning is a key component of the sociocultural theory. Guided learning involves experienced peers and adults acting as skilled instructors to teach new skills to children. Vygotsky emphasizes the importance of social interaction with adults and more capable peers as primary influences on learning, and learning is thus viewed as a socially mediated process. Since all human activity inevitably takes place within cultural settings, it cannot be understood without considering from these settings. Children interact and communicate with others in order to learn the cultural values of their society (Woolfolk, 2004).

As children grow up through the process of socialization they form a general sense of self and the ability to relate to others and participate in society. In this process they also develop beliefs about the gender roles and expectations that are associated with each

sex. As a result, their self-identity is shaped by association as a member of one sex or the other (McHale, Crouter & Whiteman, 2003). The notion of socialization is very broad and gender socialization is just one part of the large and complex process. Children's realization that they are male or female tends to come at a fairly young age long before they understand the nature of religious groups, occupations, or schooling (McHale et al., 2003). Despite cultural differences in the specific gender roles that are ascribed to males and females, the centrality of gender socialization reflects the fact all societies known to social scientists, are gendered. People throughout the world recognize that there are different sex groups and they assign different roles and responsibilities to members of these groups, as well as different rewards and values for certain behaviour (McHale et al., 2003). One of the most important socialization agents in people's early stages of life is family (Danziger, 2005). Scholars argue that the processes of family socialization might be different for men and women. From infancy, parents treat their daughters and sons differently to transmit messages about gender roles, which may have long-term effects (Mayer and Schmidt, 2004).

Patriarchal values have been the dominant gender ideology in most of the societies around the world, thus leading to the tendency to take socially constructed gender and social structure as the main elements in the understanding of gender role beliefs (Lott 1997). In China gender differences have been noted in the behaviour of men and women. Tong (2003) observed that women score significantly higher in "passive traits" than men. Traditionally, women need to stay more within the home taking care of their husband and children even if they have some formal employment. As compared with men, women have little time to explore fully political knowledge through TV watching, newspaper

reading, and talking with others, as this would seemingly make them less devoted to their familial responsibilities. The pressure families place on children for achievement is high in China for children of both sexes. However, the pressure placed on boys for high achievement far exceeds that placed on girls (Shi, 2000). There is a great deal of pressure specifically placed on Chinese boys for academic achievement and moral achievement. Family honour is emphasized greatly as members of the family, especially of the younger generation, are expected to know their place in society and to give the family name a good reputation. This pressure is especially strong for boys (Shi, 2000). As a result of this heightened pressure for boys to display moral behaviour and uphold the family name favourably in the community by showing moral behaviour and interacting positively with others, boys in China tend to be more socially active (Shi, 2000).

Dodge, Petit, McClaskey and Brown (1986) proposed a model whereby social behaviour is seen as a function of the child processing a set of social environmental cues. Their model involves a cyclical relation between social behaviour and social information processing and suggests that social interactions are a process beginning with a set of social cues. Five separate successive steps are included in this process. First, the encoding of social cues, then, the mental representation of those cues, followed by accessing potential behavioural responses, the evaluation and selection of an optimal response and lastly the enactment of that optimal response (Dodge et al., 1986). Social cues are seen as the criterion from which the child judges the social situation or task. Therefore, a child's behaviour in a social situation is hypothesized to occur as a function of the way that child processes social cues in that particular situation (Dodge et al., 1986). The manner in which processing of social cues occurs is culture specific. First, a child must

engage in event coding which involves classifying the social cues and event in terms of event types that are recognized by their culture (Mesquita & Frijda, 1992). Then the child must apply a set of interpretation rules to the encoded cues in order to derive meaning. These rules of interpretation are highly complex and culturally defined. For example, if a child has acquired through their culture a rule that calls for the interpretation of peer hostility when a scowl is observed on a peer's face, then if a scowl is encoded the child will interpret the situation as one of peer hostility and respond accordingly.

The cultural dimension most widely studied is that of collectivism versus individualism. Using these two orientations as a framework allows for comparisons between specific values and beliefs surrounding social relations in different cultures. In individualistic cultures, members of society are viewed as autonomous entities and individuation and self-focused separation are valued goals of socialization (Chen, French & Schneider, 2006b). On the other hand, collectivist cultures view individual members as embedded within the larger social context and thus orientation to the needs and desires of the group is a primary value in collectivist cultures (Chen et al., 2006b). Compared to individualistic cultures, collectivist societies place a strong emphasis on prosocial behaviour with less focus on dimensions of sociability, assertiveness or self expression. This emphasis on prosocial behaviour may be related to the primary concern about group cohesion in collectivist cultures (Chen et al., 2006b). Individualistic cultures that emphasize self discovery, self-determination and self-governance, tend to encourage expression of opinions as this is seen as relating to sociability and assertiveness (Chen et al., 2006b). Indeed, acquiring individual autonomy, competitiveness and self-expressive skills are important socialization goals in Western cultures (Maccoby & Martin, 1983).

The Chinese culture exists as a typical example of a collectivist context while Western and European American societies exemplify highly individualistic cultures.

### *Cultural Differences in Shyness-Inhibition*

Individual characteristics such as temperament may interact with cultural values to influence social functioning. While temperamental characteristics influence the development of social competence and play a significant role in adjustment, culture and temperament are fundamentally related in that culture can influence the development of personal traits and more importantly the way that they manifest and contribute to adaptive and maladaptive functioning (Chen et al., 2006a).

Perhaps due to culturally prescribed socialization practices (e.g., Chen, Hastings, Rubin, Chen, Cen & Stewart, 1998), children in different societies such as China and North America display different patterns of social functioning such as shyness-inhibition. Kagan and colleagues (1999) have categorized children who demonstrate restraint or fearfulness in the presence of unfamiliar people or situations as “behaviourally inhibited”. Behavioural inhibition to the unfamiliar refers to a temperament-based individual difference variable which can be defined as “the tendency to exhibit fearfulness, restraint, or withdrawal in the face of novel events or situations, including unfamiliar rooms, toys, peers, and adults” (Hirshfeld-Becker, Biederman, & Rosenbaum, 2004, p. 27). In social situations, shy-inhibited children tend to display quiet, reserved, wary and hovering behaviour, and these behaviours are especially obvious in groups of unfamiliar peers (Rubin et al., 2003). When shy-inhibited children initiate a social interaction, their initiations are passive as demonstrated by hovering, waiting, and non-verbal behaviour (Chen et al., 2006a).

Shyness-inhibition may be seen differently in individualistic cultures than it is in collectivist cultures. In individualistic cultures, children who display shy, inhibited behaviour are classified as socially incompetent and immature since these behaviours indicate low levels of assertiveness and social initiative (Chen et al., 2006a). In these cultures, shy, inhibited children have been found to experience lower levels of peer acceptance and problems with social adjustment. Since in Western cultures, shy children are often viewed as incompetent and even deviant by their peers, social initiations made by shy children are often negatively responded to by peers either through overt rejection behaviour or intentional ignoring (Rubin et al., 2003).

In general it is largely unknown how shy-inhibited children are involved in social interactions in different cultural contexts. Little is known regarding whether the strategies that shy-inhibited children choose to utilize to initiate social interactions differs from their non-shy counterparts, or when shy-inhibited children do not make initiations to peers, whether their peers make voluntary initiations to them. Since shy-inhibited children tend to exhibit internal anxiety and behave in ways classified as wary in social situations, they also tend to engage in fewer interactions than other children (Rubin et al., 2003). Cross-cultural differences between shyness-inhibition in Chinese children and children in North America have been reported in several studies. Overall, Chinese children generally display more shy and hesitant behaviour in novel situations than children in North America. Chen et al (1998) found that Chinese toddlers were more shy and inhibited in stressful situations and were less likely to explore and move away from their mothers in free play sessions. In addition, Chinese children exhibited more fear responses and anxious behaviour in the presence of a stranger (Chen et al., 2006a).

Chen et al (2006a) conducted a study involving four-year-old Chinese and Canadian children. Children participated in quartets in two fifteen-minute free play sessions with same-sex peers. The results indicated that shy-inhibited Chinese and Canadian children were less likely than non-shy children to make active initiations to peers. The initiations that were made by shy-inhibited children in both cultures were largely nonverbal and passive. Significant cultural differences emerged in the responses that shy children received from peers as well as in the initiations that non-shy peers voluntarily made to shy-inhibited children. When shy Canadian children made social initiations, peers did not frequently respond in positive ways such as approval, cooperation and support, but were likely to demonstrate negative responses such as disagreement, refusal or ignoring the initiation. On the other hand, the peers of shy Chinese children tended to respond more frequently in a positive manner to initiations made by shy Chinese children. Regarding peers voluntary initiations to shy children, while Canadian children initiated voluntarily to shy peers in coercive and not cooperative ways, this was not the case in China (Chen et al., 2006a). Taken together, these results support the notion that unlike Western cultures, shyness and wariness in social situations are considered acceptable and normal in social situations in Chinese culture. They also support the assertion that cultural values affect the attitudes and reactions of peers in their interactions with shy children.

#### *Culture and Social Initiative and Self-Control*

Chen et al. (2006b) proposed a two-dimensional model in which social initiative and self-control are seen as manifestations of two fundamental characteristics: reactivity and regulation. An important contribution of this contextual model is the linkage between

these fundamental dimensions (social initiative and control) and cultural values. Social initiative tends to be emphasized in individualistic cultures while self-control is seen as more crucial in collectivist cultures. One explanation for the emphasis on self-control in collectivist cultures is that self-control incorporates elements of social responsibility and concern for others (Chen et al., 2006b). In collectivist cultures, a group-orientation is in effect and children are actively encouraged to suppress their personal desires for the greater benefit and interests of the collective. Children from a very young age are taught to consider others in their decisions and to always exert self-control in their actions. In individualistic cultures, on the other hand, social-initiative is viewed as a major manifestation of social competence, maturity and assertiveness (Chen et al., 2006b). While self-control is encouraged in individualistic cultures, the cultural emphasis on individual decision making and autonomy creates the requirement for socialization agents to help children learn to balance the needs of the self with those of others. Therefore, in individualistic contexts, self-control is not as much valued as it is in collectivist cultures, especially if in conflict with the attainment of individual social and psychological goals (Chen et al., 2006a).

Recent research has shown that the value placed on the dimensions of social initiative and norm-based behavioural control in children and adolescents does in fact depend on the specific cultural context (Chen et al., 2008). Western cultures that place high value on assertive behaviour and the achievement of autonomy tend to view social initiative as an important developmental goal. On the other hand, cultures that do not strongly emphasize self-oriented or individualistic goals tend to place higher value on self-regulation and control. In these cultures, group cohesion is seen as critical and it is



the duty of socialization agents to teach children to suppress and control their own individual desires in order to achieve group wellbeing (Triandis, Bontempo, Villareal, Asai & Lucca, 1988). For example, some Asian cultures such as Chinese and Korean cultures highly appreciate and encourage discipline and perseverance. As a result, children must demonstrate behavioural control and an understanding of the general social expectations that serve to facilitate the development of control. In these cultures, a sense of group identity and a concern for others are the core values that direct children's social interaction; disputes with peers are often solved by children without teacher intervention. Lack of behavioural control is viewed as a serious problem in children and adolescence (Zhou, Eisenberg, Wang & Reiser, 2004).

In addition, the specific type of response emitted by a child to an initiation from a familiar or unfamiliar peer will be culture specific. For example, children from Western countries may tend to respond to hostility in more confrontational ways whereas children from non-Western countries such as China may tend to respond more by ignoring the hostility (Mesquita et al., 1992). Individuals from different cultures may meet different types of events and be affected differently by particular events. The range of events an individual is emotionally sensitive to is one result of their group characterization (Mesquita et al., 1992). Cultural differences in behaviour response may result from culture-specific behavioural repertoires. These culture-specific repertoires are developed based on culturally defined expectations regarding behaviour that is appropriate under certain situations (Mesquita et al., 1992).

*Gaps in the field*

In the study of children's peer interactions and behaviour, observational methods are often seen as the most effective and appropriate (Fabes, Martin & Hanish, 2008). A major strength of observational research is that it provides "objective" data and allows for in-depth analysis of actual interaction (Corsaro, 2006). This is particularly important for cross-cultural studies because cross-cultural comparisons using other methods such as self-reports or teacher and parent ratings often suffer from problems of response biases (e.g., Chinese people tend to select the middle points in rating scales, (Chen, Lee & Stevenson, 1995) and the "reference group" biases (e.g., teachers often rates each child according to the norm within the class (Peng, Nisbett, & Wong, 1997). Unfortunately, there is inadequate empirical research on peer interactions using observational methods. Cross-cultural research on peer interactions based on observation almost does not exist, with only a few exceptions (e.g., Chen et al., 2006a).

The existing observational research has focused on peer interactions either with friends or with unfamiliar peers, but not both. However, in some social situations children experience interactions with friends and unfamiliar peers at the same time. It may be interesting to explore peer interactions in situations where both friends and unfamiliar peers are present and compare children's behaviour directed toward familiar and unfamiliar peers

Further still, in previous studies there has been little focus on specific behaviour that children exhibit during peer interactions. The previous literature has focused mainly on quantifying the frequency of initiations and responses children make and receive

during interactions with peers, while not necessarily concentrating on the actual type of behavioural initiation or response made.

Furthermore, despite the advances in our understanding of how peer interactions occur as well as their developmental significance, much of what we know today is based on North American and Western European children. Little is known about the peer interactions of children in other cultures. As a result, the existing literature provides limited information on how peer relations may vary as a function of children's social and cultural contexts. This is a significant limitation since the skills and competencies that children acquire in development are intrinsically bound to the culture within which they live (Chen & French, 2008). It is necessary to shift from thinking about peer interactions as culture-free towards an understanding of peer interactions as embedded within a cultural system.

#### *Summary, Research Questions and Hypotheses*

In this study, I focused on two specific behaviours during peer interactions: prosocial behaviour and expression of opinion. The two behaviours are culturally relevant, especially when comparing children in individualistic and group-oriented societies (e.g., Chen & French, 2008; Greenfield et al., 2006; Triandis, 1995). This study is also unique in its focus on the manifestation of these behaviours during free play interactions involving both friends and unfamiliar peers in the same setting. Of course, the cultural focus of this study through comparing Chinese and Canadian children would provide an understanding of the role of cultural context in affecting social behaviour and peer interactions.

The primary aim of the current study was to examine how the context of familiarity (friends, non-friends vs. mixed playmates) interacts with culture to influence the exhibition of prosocial and self-expressive behaviour in children's peer interactions. In general, this study aimed to address three major research questions.

Research question 1: Do Chinese children demonstrate more prosocial behaviour than Canadian children during peer interactions? I expected that Chinese children would demonstrate higher levels of prosocial behaviour to both friends and non-friends during interactions. Prosocial behaviour is linked to the maintenance of harmony in social interactions. Research has indicated that cooperation and group cohesion are highly encouraged in Chinese culture (e.g., Triandis, 1995). Children from very young ages are often purposefully and consistently trained to display self-control, cooperation and prosocial behaviour in the Chinese culture (e.g., Chen, Rubin, Liu, Chen, Wang, Li, Gao, Cen, GU & Li., 2003; Ho, 1986). According to Miller (1994), individuals in sociocentric societies view responsiveness to the needs of others to be a fundamental commitment, whereas individuals in Western societies attempt to maintain a balance between prosocial concerns and individual freedom of choice. Thus, prosocial-cooperative behaviour is seen in Western cultures as a personal decision based on such factors as the relationships with the target person (e.g., friend vs. non-friend) and how much one likes the person. In societies that value group harmony, however, there is considerable pressure on children to view prosocial-cooperative behaviour toward others as obligatory (e.g., Miller, 1994). Based on this argument, I expected that the differences between Chinese and Canadian children in prosocial behaviour may be more salient in interactions with unfamiliar peers.

Research question 2: Do Chinese children demonstrate less self-expressive behaviour than Canadian children? Based on the argument about the values of social initiative in collectivist and individualistic cultures (Chen et al., 2006b) as well as the research findings concerning shyness-inhibition and its implications for peer interactions in Chinese and Canadian children (e.g., Chen et al., 2006a), I expected that Chinese children would have lower levels of self-expressive behaviour than Canadian children in both familiar and unfamiliar contexts. Sociability, independence emotional openness are characteristics that are considered important indications of social competence in Western cultures. The emphasis on “independent” self in individualistic cultures (Markus & Kitayama, 1991) is likely to facilitate the development of individuality, self-direction and expression of feelings and opinions. In contrast, children in China are often taught to suppress their own personal feelings, desires and opinions and to act in ways that help maintain group consensus. Therefore, Canadian children, in general, may exhibit higher levels of self-expressive behaviour than Chinese children in interactions. Given that Chinese children tend to be more shy, anxious and inhibited than Canadian in novel and challenging situations (e.g., Chen et al., 1998; Lee, Okazaki, & Yoo, 2006), I expected that the difference between the samples in self-expression would be more evident in interactions with unfamiliar peers.

Research Question 3: Regardless of culture do girls show higher levels of prosocial and self-expressive behaviour compared to boys? Given the literature on gender differences (e.g., Chen, Rubin & Li, 1995; Maccoby, 2002), I expected that girls would have higher scores on both prosocial behaviour and self-expression than boys in both cultures. Previous research shows that females and males differ in the number of friends

with whom they interact. Males spend more time in coordinated group activity, and females engage in longer episodes of dyadic interaction (Benenson et al., 1997). Thus, although I expected that there would be more prosocial and self-expressive behaviour in interactions with friends than with non-friends or mixed playmates in general, the social behaviour might be displayed relatively more frequently in dyadic interactions with friend for girls than for boys and relatively more frequently in mixed or group context for boys than for girls. Girls are more likely than boys to disclose thoughts and feelings to others (Benenson et al., 1997; Papini, Farmer, Clark, Micka, & Barnett, 1990). In addition, there is evidence that girls tend to display more prosocial behaviour than boys (e.g., Eisenberg et al., 2006).

In addition, I expected some three way interactions between culture, context and gender. For example, as a result of the Chinese cultural values of group cohesion and harmony as well as the gender socialization of boys in China and the fact that Chinese boys tend to be less shy than Chinese girls, I expected that Chinese boys would display the most prosocial behaviour when interacting in a mixed playmate context. I expected this due to the rationale that once Chinese boys began interacting in a mixed playmate context they would think of the non-friend(s) they were now interacting with as part of their group instead of just part of another group. As a result of this, I expected Chinese boys would feel heightened pressure to display positive behaviour to their now group members in order to show they were behaving morally and maintaining group cohesion and harmony.

## Method

### *Participants*

Data for this study were drawn from a larger cross-cultural longitudinal project examining children's socio-emotional development and functioning in China and Canada. A total of 35 Chinese ( $N=140$  children) and 33 Canadian ( $N=132$  children) groups of children were included in this study. The average ages of children participating in this study were 11.78 ( $SD=.54$ ) for Canadian children and 10.81 ( $SD=.70$ ) for Chinese children. The average ages of mothers were 41.63 ( $SD= 3.55$ ) and 39.20 years old ( $SD= 3.73$ ) for Canadian and Chinese mothers respectively. The average ages of fathers were 43.01 ( $SD= 4.42$ ) and 41.49 years old ( $SD= 4.30$ ) for Canadian and Chinese fathers respectively. Seventy percent of Canadian mothers had college or university education compared to 62% of Chinese mothers. Sixty-two percent of both Canadian and Chinese fathers had college or university education (note that "college" education in China included professional training schools, which may be lower than college education in Canada).

### *Procedure*

*Recruitment.* In the initial study, participants were located through newspaper birth announcements in Canada and through local birth registration offices in China and then recruited through telephone solicitation. In 2005, parents of children who had participated in the original study were contacted again by telephone and asked to participate in a follow up data collection.

*Laboratory observations.* Participants visited the University laboratories in quartets to take part in a video-taped peer interaction session. All groups were of the same-sex and were formed by random assignment. Each group consisted of two pairs of

friends so that each child had one friend in their group and two non-friends. Parents received monetary compensation for their and their children's participation.

Prior to their arrival parents and children were asked to read a letter of information and sign a consent form (see Appendix A) outlining the purpose and procedure of the study. On the day of participation, parents were then taken to one room to complete a set of questionnaires, and children were taken to a playroom. Toys were arranged in the same format prior to each laboratory session to ensure that each group of children was exposed to a similar environment as they entered the playroom. The entire playroom session took place in a room with a one-way mirror and was videotaped. Parents and children were aware that the playroom session was being videotaped for research purposes.

The entire observation lasted 75 minutes, during which children participated in a standardized observational paradigm designed to elicit different aspects of socio-emotional development and functioning. The entire observational paradigm consisted of (a) free play (15 min.), (b) clean up (5 min.), (c) helping session (1 min.), (d) group discussion during which children were given different topics to discuss amongst themselves (15 min.), (e) "space shuttle" construction session (4 min.), (f) free play #2 (10 min.), (g) clean up #2 (3 min.), and (h) special toy session (5 min.). (see Appendix B for script of entire session). The data used for this study were based on the first free play session. The procedure was identical in the two samples.

### *Coding*

Twelve specific types of behaviour were coded as follows: cooperative play, prosocial/helping behaviour, polite/positive comment or praise, personal/private/intimate



disclosure, discussion of third person topic, expression of opinions, problem solving/dissolving issue, negative involvement, conflict/disagreement, aggression/hostility, competition, sarcasm/ridicule. Affect was also coded as positive, negative or neutral (see Appendix C for complete coding scheme).

*Prosocial behaviour.* The code for prosocial behaviour was used when children appeared to be getting along well with each other and were clearly cooperative in their interactions. This code refers to explicitly pleasant, nice and considerate behaviour shown toward each other. In order for this code to be utilized it was necessary that children be respectful of each other and that they display prosocial and helpful behaviour. When displaying prosocial behaviour, children also made kind and polite requests. Some examples of when prosocial behaviour would be indicated are a child saying "Would you like to play this game with me?" or "Would you like to build this together?", a child helping another build something, or a child complying to a request for help kindly and willingly.

*Self-expressive behaviour.* The construct of self-expressive behaviour was intended to capture the tendency to share opinions and judgements about other people or things. This behaviour was coded when children engaged in a friendly discussion where they were expressing their views and sharing their opinions and thoughts about other people, things or events (e.g., "I like that movie too, but my favourite is Happy Feet.")<sup>1</sup>

---

<sup>1</sup> For the purposes of my analysis, I initially considered aggregating expression of opinions and personal self-disclosure, but eventually decided not to do so. Personal self-disclosure in the form of revealing information or facts about oneself is different in nature from self-expression in the form of sharing feelings, opinions and judgements about other people, things or events, since personal self-disclosure involves the cultural value of privacy. While Western cultures may see privacy as related to the notion of individualism, Chinese culture may view it as related to self-control and restraint. As a result, both cultures may not encourage personal and private disclosure during social interactions, especially in the presence of unfamiliar peers. Therefore, only the code for expression of opinion was considered in order to capture self-expressive behaviour.

Time sampling was used so that every 30 seconds the most dominant behaviour that occurred was coded. For each time sample, the level of interaction was coded as well (i.e. dyadic, triadic or group) so that it was noted for every behaviour whether the child(ren) involved were interacting with their friend, one or two non-friends, or their friend and one or two non-friends (mixed playmates).

One graduate student and two trained undergraduate students coded the videos included in this study. All coders were trained following the same procedure. Interrater reliability was established based on 32 children (8 randomly selected quartets of children). Interrater reliability was calculated using Cohen's kappa (2003). Cohen's kappa for the reliability across the fifteen types of initiations and thirteen types of responses were .86 and .83 respectively. The reliability for prosocial behaviours to friend, non-friend and mixed playmate were .83, 1.00, and .78 respectively and the reliability for self expressive behaviour to friend, non-friend and mixed playmate were .87, 1.00, and .90 respectively.

## Results

Table 1 shows the means and standard deviations of prosocial and self-expressive behaviour. A 2 (culture: Canadian and Chinese) X 2 (gender: boys and girls) MANOVA with repeated measures on the playing context (with friend, non-friends or mixed) was conducted on the social behaviour data.

As expected, an overall significant *main effect of culture* emerged, Wilks  $\lambda = .89$ ,  $F(2, 267) = 16.38$ ,  $p < .001$ . Tests of between-subjects effects showed that Chinese children ( $M = 19.37$ ,  $SD = 6.51$ ) displayed more prosocial behaviour than their Canadian partners ( $M = 15.10$ ,  $SD = 6.73$ ),  $F(1, 268) = 31.43$ ,  $p < .001$ , while Canadian children ( $M = .81$ ,  $SD = 1.27$ ) displayed more self-expressive behaviour than Chinese children ( $M = .36$ ,  $SD = .74$ ),  $F(1, 268) = 14.26$ ,  $p < .001$ .

In order to test whether the prosocial behaviour and self-expressive means were different from zero, a *t*-test was conducted. Self-expression to non-friend was found not significant different from zero when both samples were put together ( $t = 1.00$ ,  $df = 271$ ,  $p > .05$ ). This indicates that this kind of behaviour appears by chance. When the samples were taken separately, the results indicated that for Canadian children the mean score of prosocial to non-friends was not significantly different from zero ( $t = 1.91$ ,  $df = 131$ ,  $p > .05$ ). The results also indicated that for Chinese children the mean score of self-expressive behaviour to non-friends was not significantly different from zero ( $t = 1.00$ ,  $df = 139$ ,  $p > .05$ ).

Moreover, an overall significant *main effect of context* was found,  $\lambda = .08$ ,  $F(4, 265) = 745.64$ ,  $p < .001$ . The main effect was significant for both prosocial and self-expressive behaviour,  $F(2, 536) = 310.38$  and  $37.41$ ,  $ps < .001$ , respectively. Post-hoc (LSD) analyses revealed that prosocial behaviour happened more often when children

played with friend than with mixed playmates, and more often when children played with mixed playmates than with non-friends ( $M = 12.69, 4.39$  and  $.11, SD = .49, .27$  and  $.03$ , respectively). Self-expressive behaviour happened more often when children played with mixed playmates than with friend, and friend than non-friends ( $M = .44, .12$  and  $.00, SD = .06, .02$  and  $.00$ , respectively).

A *gender X culture interaction* was found on both variables,  $\lambda = .92, F(2, 267) = 11.77, p < .001$ . Further analyses indicated that the interaction was significant only for self-expressive behaviour,  $F(1, 268) = 13.83, p < .001$ . Simple main effect analysis showed that Chinese girls displayed more self-expression than Chinese boys,  $F(1, 138) = 16.74, p < .001$ . However, there was no significant difference between boys and girls in the Canadian sample.

The results also showed a significant *context X culture interaction*,  $\lambda = .83, F(4, 265) = 13.60, p < .001$ . Simple effect analysis indicated that the interaction was mainly on self-expressive behaviour,  $F(2, 536) = 20.15, p < .001$ . Canadian children displayed these behaviours more often than Chinese children in their interactions with mixed playmates,  $t(270) = -4.60, p < .001$ . There were no significant cultural differences in the other two contexts. A *gender X context interaction* was found, too,  $\lambda = .91, F(4, 265) = 6.74, p < .001$ . Further analysis demonstrated that the interaction was significant for both prosocial and self-expressive behaviour,  $F(2, 536) = 9.75$  and  $4.94, p < .001$  and  $.05$ , respectively. Girls ( $M = 14.29, SD = 8.73$ ) had higher prosocial scores than boys ( $M = 11.49, SD = 7.47$ ) in the context with friend, whereas boys ( $M = 5.26, SD = 5.13$ ) had higher prosocial scores than girls ( $M = 3.30, SD = 4.13$ ) in the context of

mixed playmates. In addition, girls ( $M = .22$ ,  $SD = .50$ ) had higher self-expression scores than boys ( $M = .03$ ,  $SD = .17$ ) in interactions with friends, but not others.

A *three way interaction* was found (gender X culture X context)  $\lambda = .87$ ,  $F(4, 265) = 10.31$ ,  $p < .001$ . Further analysis indicated that context X gender interaction was significant in the Chinese sample,  $F(4, 135) = 14.63$ ,  $p < .001$ , but not in the Canadian sample. In the Chinese sample, the interaction was significant for prosocial behaviour,  $F(2, 276) = 22.28$ ,  $p < .001$ . Post-hoc analysis revealed that Chinese girls displayed more prosocial behaviour than boys with friends but fewer prosocial behaviour than boys with mixed playmates,  $t(138) = -4.19$  and  $4.95$ ,  $p < .001$ , respectively. There was no significant gender difference with non-friend (see Figure 1). Taken together the analyses indicated that Chinese girls showed more prosocial behaviour with friends, and Chinese boys showed more prosocial behaviour with mixed playmates. Chinese boys, Canadian girls and Canadian boys did not significantly differ from each other in interactions with friend, and Chinese girls, Canadian girls and Canadian boys did not significantly differ in interactions with mixed playmates.

In order to see if there were cross-cultural differences in how many dyad, triad and group interactions were coded for prosocial behaviour and self-expressive behaviour prosocial and self-expressive behaviour were aggregated. Data coded for friends were put together, non-friends together and mixed together (regardless of the behaviour) and a MANOVA was conducted for cross-cultural differences. A significant difference emerged for "friend" level which means Chinese children behaved more interactions with friends than Canadian children did ( $\lambda = .92$ ,  $F(1, 270) = 8.84$ ,  $p < .001$ .)

In summary, regarding cultural differences, the results showed that Chinese children (mainly boys in interactions with mixed playmates and girls in interactions with friends) displayed more prosocial behaviour than Canadian children. Canadian children displayed more self-expressive behaviour than Chinese children, mainly in interactions with mixed playmates. Regarding gender differences, girls displayed more prosocial and self-expressive behaviour than boys in interactions with friend, whereas boys displayed more prosocial scores than girls in interactions with mixed playmates.

Figure 1. Frequency scores of prosocial and self-expressive behaviour

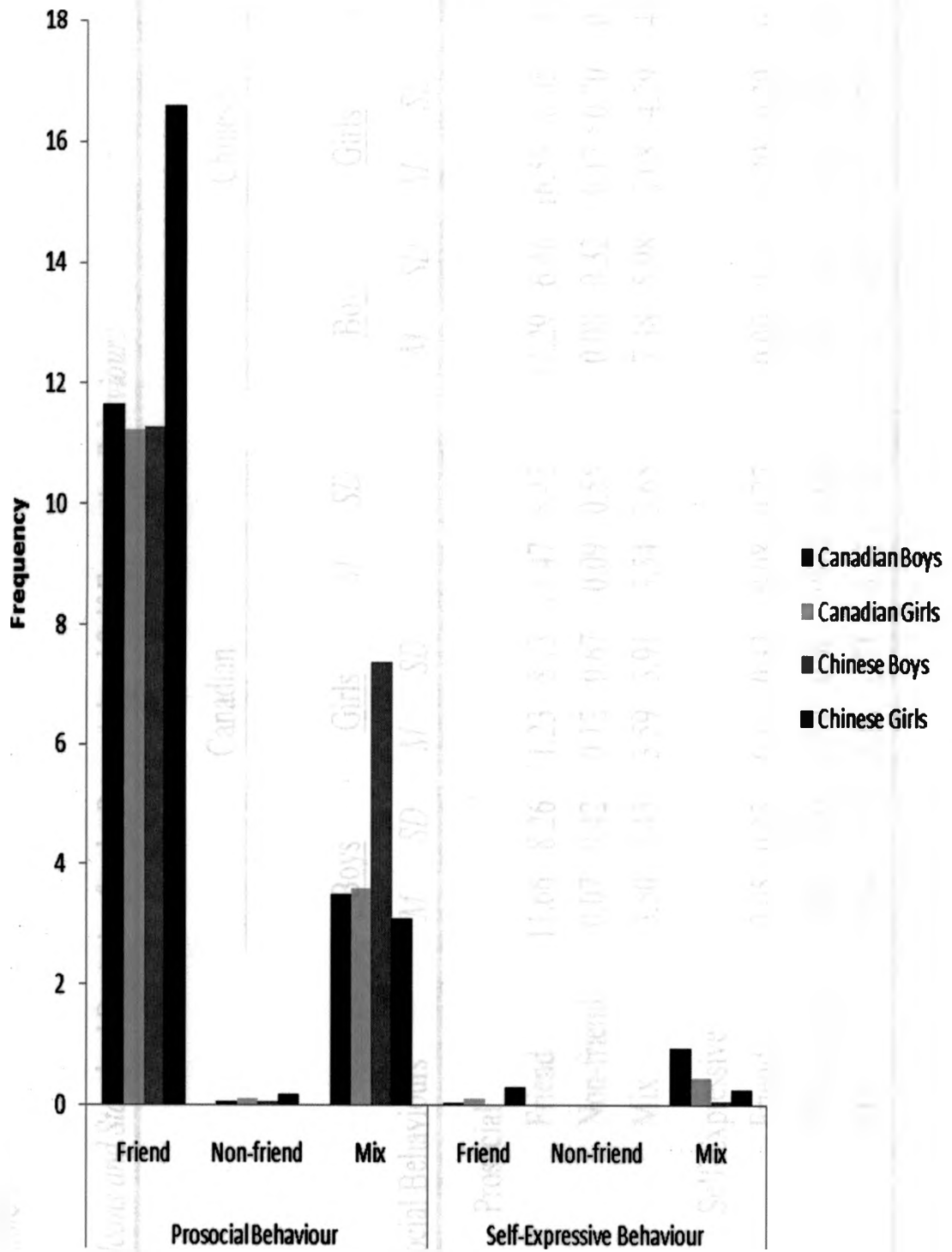


Table 1

*Means and Standard Deviation for the Prosocial and Self-Expressive Behaviours*

	Canadian						Chinese					
	<u>Boys</u>		<u>Girls</u>		<i>M</i>	<i>SD</i>	<u>Boys</u>		<u>Girls</u>		<i>M</i>	<i>SD</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Social Behaviours												
Prosocial												
Friend	11.66	8.26	11.23	8.73	11.47	8.45	11.29	6.46	16.59	8.05	14.32	7.84
Non-friend	0.07	0.42	0.12	0.67	0.09	0.55	0.08	0.32	0.17	0.70	0.13	0.57
Mix	3.50	3.45	3.59	3.91	3.54	3.65	7.38	5.98	3.08	4.29	4.92	5.49
Self-Expressive												
Friend	0.05	0.23	0.11	0.32	0.08	0.27	0.00	0.00	0.29	0.29	0.17	0.47
Non-Friend	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.01	0.08
Mix	0.94	1.56	0.46	0.71	0.72	1.26	0.07	0.28	0.25	0.71	0.18	0.57



## Discussion

Children's behaviour reflects the values of the society in which they live. While human development is related to genetic influence, the socialization process can mold it in particular directions by specifying socialization goals, encouraging certain behaviours and discouraging others, and providing setting conditions to facilitate culturally valued behaviours or suppress unfavorable behaviours. Cultural values of behaviours are likely to be reflected in social interactions. Through culturally directed social interactions, particularly the evaluation and response processes (Chen et al., 2008), the display of specific behaviour may be facilitated or weakened. In other words, the behaviour and skills that children are expected to acquire within social interactions are shaped by the broader cultural context.

### *Cross-Cultural Differences in Prosocial Behaviour*

In the Chinese culture, interdependence of individuals in society is a strongly established ideal and harmony and balance in social relationships are sought (Ji et al., 2000). Socialization efforts focused on instilling the importance of such interdependence lead individuals towards a constant striving for smooth interpersonal interactions (Best & Ruther, 1994; Ting-Tomey, 1991; Keller, 2004). This desire in Chinese culture to establish and maintain harmonious interpersonal relationships often results in the suppression of personal desires to benefit the larger group (Chen et al., 2006b). The display of prosocial behaviour among members of society contributes to harmonious interpersonal relationships and group functioning. Thus, Chinese parents make purposeful and extensive efforts to train children from very young ages to demonstrate prosocial behaviour (Chen & French, 2008; Grusec et al., 2004; Fujisawa et al., 2008).

For example, Chinese parents encourage their children to adapt themselves to accommodate the need of others and make their children exposed to situational contexts that specifically target their helping skills. Some researchers suggest that the availability and frequency of these learning opportunities may be related to the emphasis placed on social responsibility (Grusec et al., 2004). Chinese parents often model deference and avoidance of confrontations so that their children can learn from them (Ho, 1986; Ji, et al., 2000). Consistent with these arguments, the results of the present study indicated that, in general, Chinese children displayed higher prosocial behaviour than Canadian children in peer interactions. In the long run, more prosocial behaviour in Chinese children may contribute to the development of morally responsible members of society, which is viewed as ultimate developmental goals in Chinese culture (Ji et al., 2000; Wang, Stevens, Chen & Qian, 1999).

Nevertheless, cultural influence on children's social behaviour may not occur in a straightforward manner. I initially expected that the differences between Chinese and Canadian children in prosocial behaviour would be more salient in interactions with unfamiliar peers. This expectation was not supported. First, Chinese children did not show more prosocial behaviour than Canadian children to non-friends. Children in both samples displayed little prosocial behaviour. Compared to interactions with non-friends, interactions with friends and mixed playmates elicited more prosocial behaviour. There may be different reasons for the display of prosocial behaviour or lack of it in Chinese and Canadian children. As a result of their socialization to be prosocial to everyone, Chinese children may be inclined to be prosocial in most social situations. This general tendency of displaying prosocial behaviour in Chinese, however, may be hindered or

suppressed by their shy-anxious reactions to the stressful and challenging situations involving unfamiliar peers. This explanation is consistent with the findings that Chinese boys, who are less shy-anxious in unfamiliar situations (e.g., Chen et al., 1995), displayed more prosocial behaviour than girls to mixed playmates and that Chinese girls displayed most prosocial behaviour in non-stressful interactions with friends. Since Canadian children may demonstrate prosocial behaviour largely based on their interest and personal relationships (e.g., Eisenberg et al., 2006), the lower levels of prosocial behaviour to non-friends could indicate a lack of interest to demonstrate prosocial behaviour to unfamiliar peers. This explanation could also account for the results indicating that for Canadian children the mean score of prosocial to non-friends was not significantly different from zero, meaning that it probably occurred by chance. In the mixed playmate context, Canadian children demonstrated more prosocial behaviour. Although the mixed context involved one friend and one or two non-friends, it seems reasonable to speculate that the prosocial behaviour is largely directed to the friend in this context given the lack of prosocial behaviour in the non-friend situation.

#### *Cross-Cultural Differences in Expression of Opinion*

In the West where individuation is considered important in child development, parents strive to teach their children how to function independently and to fulfill their self-directed goals. Western parents highly value autonomy, and therefore place great emphasis on their children's social initiative, self-expression, and personal achievement (Greenfield et al., 2006; Tietjen, 2006; Triandis, 1995). During socialization, children are also encouraged to be assertive in social interactions in Western societies (Greenfield et al., 2006). Expression of opinions may be an important indication of autonomy and social

assertiveness. The results of the present study, in general, supported these arguments. Canadian children displayed more self-expressive behaviour than Chinese children.

The results concerning self-expression may also be related to the differences between Chinese and Canadian children in shyness-inhibition. It is possible that demonstrating a lack of self-expressive behaviour is understood by Chinese children as displaying restraint and self-control. Previous research shows that overall, Chinese children display more shy and reticent behaviour in novel situations than children in North America (Chen et al 1998). Moreover, the social initiations that are made by shy-inhibited Chinese children to peers are largely nonverbal and passive (Chen et al., 2006a). Since self-expressive behaviour as assessed in this study is both verbal and active, it would seem unlikely that shy-inhibited children would demonstrate high levels of this behaviour.

Similar to the results concerning prosocial behaviour, cross-cultural differences in self-expression was moderated by context. The higher level of self-expression in Canadian children emerged mainly in the mixed playmate interaction. The results also indicated that for Chinese children the mean score of self-expressive behaviour to non-friends was not significantly different from zero, which could indicate that when self-expressive behaviour to non-friend by Chinese children did occur, it was by chance. Again, in the most stressful situation (non-friend context), both Chinese and Canadian children displayed little self-expressive behaviour. However, Canadian children did demonstrate more self-expression in the mixed playmate context. Therefore, my second hypothesis only was partially supported by the pattern of self-expression seen in the mixed playmate context.

*Friend vs. Unfamiliar Peer: The Role of Context*

Regardless of culture, peer context was found to play a significant role in the manifestation of prosocial and self-expressive behaviour. In general, prosocial behaviour occurred more often when children played with a friend than with mixed playmates (i.e. a friend and non-friend). Prosocial behaviour was also demonstrated more often when children played with mixed playmates than with one or two non-friends only. These findings support the notion that friendships provide children with a unique context. The results are also consistent with the previous research showing that interactions with friends are characterized by more intense affective and affiliative features (Newcomb & Bagwell, 1996).

Self-expressive behaviour occurred more often when children played with mixed playmates (one friend and at least one non-friend) than with friends and more often with friend than non-friends. This could indicate that while children remain more hesitant to disclose information about themselves to non-friends, when in a context of mixed playmates, self-expression can be used by children as a tool for initiating and maintaining social interactions. In the mixed playmate context children had a friend present. The presence of their friend could have provided them with the necessary sense of security to feel confident to initiate interactions with the unfamiliar peer(s). One of the simplest ways of initiating interaction could be through the expression of opinions to trigger conversation (Newcomb & Bagwell, 1996). Interestingly, the presence of one or two familiar peers and a friend (mixed play context) appears to be more effective than the friend context in triggering self-expressive behaviour.

### *Gender Differences*

The culture by gender interaction found in this study revealed that Chinese girls displayed more self-expressive behaviour than Chinese boys did. This may be related to the general gender difference previous research shows in the self-expressive behaviour of boys and girls during peer interactions (e.g., Maccoby, 1998). However, further research is required to increase our understanding of why this gender difference occurs only in Chinese children and what specific cultural factors may contribute to increased self-expression in Chinese girls compared to Chinese boys during free-play peer interactions. Additional research is required to understand the apparent paradox that, relative to Chinese boys, Chinese girls display higher shyness-inhibition and higher self-expressive behaviour at the same time.

### *Conclusions, Contributions of the Study, and Limitations*

Since culture consists of socialization goals, beliefs and values in a society, it is an undeniable fact that cultural factors play an important role in children's socioemotional, behavioural and cognitive development. However, despite the arguments about the importance of culture (e.g., Greenfield et al., 2006), much of what we know today is still largely based on North American and Western European studies. Most studies of social interactions, including those of peer relationships, are described in the literature such as textbooks with an implicit assumption that the basic rules and values about children's interactions in Western cultures are universally shared around the world. However, the existing research indicates that the culturally structured goals for the socialization of children and the daily activities that children engage in do differ widely by culture (Whiting & Edwards, 1988; Gaskins, 2000). Unfortunately, there is little

research on children's peer interactions and relationships in non-Western cultures. As a result, limited information is available on how the behaviour children display during social interactions with peers varies as a function of their social and cultural environments.

In this study, I chose to focus on two key types of behaviour exhibited during peer interactions, namely prosocial behaviour and self-expressive behaviour. Based on the notion that the socialization goals for children vary by culture, I expected that the investigation of prosocial and self-expressive behaviour in a highly collectivist and an individualistic cultures would reveal some cross-cultural differences that are consistent with the corresponding cultural orientations. The inclusion of both friend and unfamiliar peers in the study was also expected to reveal interesting information on cultural influence on individual behaviour through shaping social relationships such as friendship and children's reactions to setting conditions such as novelty and stress. The results of the study indicate that culture and peer context may interact in a sophisticated manner in their contributions to the exhibition of social behaviour.

Nevertheless, it will be important to explore how culture and social context affect the internal processes involved in children's social behaviour. For example, because shyness-inhibition is viewed in the Chinese culture as a manifestation of restraint and self-control which are highly valued, it is possible that Chinese children interpret their lack of self-expression as acting in according with the cultural values, indicating cautiousness, modesty and social maturity. On the other hand, in Western cultures, shy children are often viewed as incompetent and even deviant by their peers, and shy, inhibited children have been found to experience lower levels of peer acceptance and

problems with social adjustment (Rubin et al., 2003). Therefore, it may be the case that Western children view the demonstration of self-expressive behaviour to be indicative of social competence and beneficial to the promotion of peer acceptance. A further exploration of how peer context affects the behaviour exhibited by children in different cultures would help us achieve an in depth understanding of how context and culture interact in determining human development. It will also be useful for professionals to design culturally appropriate and effective intervention programs to help children improve the quality of their social interactions.

In reviewing the literature on self-expressive behaviour, I found little research on self-expressive behaviour specifically. As a result, my review includes self-disclosure as well. While self-disclosure and self-expressive behaviour may not be exactly the same in nature, self-expressive behaviour is noted as a type of self-disclosure and the two constructs can be thought of as different forms of expressing a similar intention, namely, to share ones thoughts, feelings and ideas with others.

It is also important to note that I did not have complete control of the effects of group size, especially in interactions beyond the dyad. In the triad interaction known as the mixed playmate context, children were playing with a friend and one or two non-friends so we do not know whether group size affected the specific behaviour that was manifested by any particular child involved in the interaction.

In addition, it is important to mention that I used time sampling to code the interaction data. As a result of the coding method, certain behaviour might not be captured because they were not the most dominant behaviour in a given time period. Time sampling, also referred to as interval sampling, focuses on relatively few, specific,



well-defined behaviours rather than the entire stream of ongoing behaviour. High observer agreement can be achieved with time sampling since observers only need to agree on whether or not the behaviour of interest occurred at least once in the given time segment. However, time sampling limits the types of behaviours that are observed since simultaneous behaviours are often avoided. Sequences of interactions are also not recorded with time sampling.

Finally, because I used the free play situation, certain behaviour may not have been manifested. Therefore, it would be interesting to examine children's behaviour in different settings with both their friends and unfamiliar peers present. In spite of the limitations and weaknesses, the present study provided valuable information about cultural involvement in children's social functioning in peer interactions.

## References

- Bandura, A. (1969). *Principles of Behaviour Modification*. New York: Holt, Rinehart & Winston.
- Bandura, A. (1977). *Social Learning Theory*. New York: General Learning Press.
- Bauminger, N., Finzi-Dottan, R., Chason, S., Har-Even, D. (2008). Intimacy in adolescent friendship: The roles of attachment, coherence, and self-disclosure. *Journal of Social & Personal Relationships*, 25 (3), 409-429.
- Berndt, T.J. (1981). Effects of friendship on prosocial intentions and behaviour. *Child Development*, 52, 636-643.
- Berndt, T. J., Hawkins, J. A., & Jiao, Z. (1999). Influences of friends and friendships on adjustment to junior high school. *Merrill-Palmer Quarterly*, 45, 13-41.
- Berndt, T. J., & Hanna, N. A. (1995). Intimacy and self-disclosure in friendships. In K. J. Rotenberg (Ed.), *Disclosure processes in children and adolescents* (pp. 57-77). New York: Cambridge University Press.
- Berndt, T.J. (2002). Friendship quality and social development. *Current Directions in Psychological Science*, 11, 7-10.
- Benenson, J.F., Apostoleris, N.H., & Parnass, J. (1997). Age and sex differences in dyadic and group interaction. *Developmental Psychology*, 33, 538-543.
- Benenson, J.F., & Christakos, A. (2003). The greater fragility of Females' versus males' closest same-sex friendships. *Child Development*, 74, 1123-1129.
- Best, D. L., & Ruther, N.M. (1994). Cross-cultural themes in developmental psychology. An examination of texts, handbooks and reviews. *Journal of Cross-Cultural Psychology*, 25, 54-77.

- Brendgen, M., Markiewicz, D., Doyle, A.B., & Bukowski, W.M. (2001). The relations between friendship quality, ranked-friendship preference, and adolescents' behaviour with their friends. *Merill-Palmer Quarterly*, 47, 395-415.
- Bronfenbrenner, U. (1979). *The Ecology of Human Development*. Cambridge, MA: Harvard, University Press.
- Bronfenbrenner U., & Morris P.A. (1998). The ecology of developmental processes. In R.M. Lerner (Ed.). *Handbook of Child Psychology: Vol 1. Theoretical Models of Human Development*, (pp. 993-1028). New York: Wiley.
- Buhrmester, D., & Furman, W. (1987). The development of companionship and intimacy. *Child Development*, 58, 1101–1113.
- Bukowski, W.M., Newcomb, A.F., & Hartup, W.W. (1996). Friendship and its significance in childhood and adolescence: Introduction and comment. In W.M. Bukowski, A.F. Newcomb, & W.W. Hartup (Eds.). *The company they keep: Friendship in childhood and adolescence* (pp. 1-18). Cambridge: Cambridge University Press.
- Bukowski, W., & Hoza, B. (1989). Popularity and friendship: Issues in theory, measurement, and outcome. In T. J. Berndt & G. W. Ladd (Eds.), *Peer relationships in child development* (pp. 15–45). New York: Wiley.
- Chen, X., Li, D., Li, Z., Li, B., & Liu, M. (2000). Sociable and prosocial dimensions of social competence in Chinese children: Common and unique contributions to social, academic and psychological adjustment. *Developmental Psychology*, 36, 302-314.

- Chen, X., DeSouza, A., Chen, H., & Wang, L. (2006a). Reticent behaviour and experiences in peer interactions in Canadian and Chinese children. *Developmental Psychology, 42*, 656-665.
- Chen, X., French, D.C., & Schneider, B.H. (2006b). *Peer relationships in cultural context*. New York: Cambridge University Press.
- Chen, X., & French, D. (2008). Children's social competence in cultural context. *Annual Review of Psychology, 59*, 591-616.
- Chen, X., Hastings P., Rubin, K.H., Chen, H., Cen G., & Stewart, S.L. (1998). Childrearing attitudes and behavioural inhibition in Chinese and Canadian toddlers: A cross-cultural study. *Developmental Psychology, 34*(4), 677-686.
- Chen, X., Rubin, K. H., & Li, Z. (1995). Social functioning and adjustment in Chinese children: A longitudinal study. *Developmental Psychology, 31*, 531-539.
- Chen, X., Rubin, K. H., Liu, M., Chen, H., Wang, L., & Li, D., Gao, X., Cen, G., Gu, H., & Li, B. (2003). Compliance in Chinese and Canadian toddlers. *International Journal of Behavioural Development, 27*, 428-436.
- Chen, C., Lee, S.-Y., & Stevenson, H. W. (1995). Response style and cross-cultural comparisons of rating scales among East Asian and North American students. *Psychological Science, 6*, 170-175.
- Cicchetti, D. (1990). A historical perspective on the discipline of developmental psychopathology. In J. Rolf, A. S. Masten, D. Cicchetti, K. H. Nuechterlein, & S. Weintraub (Eds.), *Risk and protective factors in the development of psychopathology* (pp. 2-28). New York: Cambridge University Press.
- Colarossi, L. G., & Eccles, J. S. (2000). A prospective study of adolescents' peer support:

Gender differences and the influence of parental relationships. *Journal of Youth and Adolescence*, 29, 661-678.

Corsaro, W. A. (2006). Qualitative research on children's peer relations in cultural context. In X. Chen, D. French., and B.H. Schneider, (Eds.) *Peer-Relationships in Cultural Context* (pp. 96- 102). Cambridge NY: Cambridge University Press.

Cowen, E. L. & Kilmer, R. P. (2002). Positive psychology: Some plusses and some open issues. *Journal of community psychology*, 30 (4), 449-460.

Danziger, J. N. 2005. Understanding the political world: A comparative introduction to political science. NY: Pearson Longman.

Deater-Deckard, K. (2000). Parenting and child behavioural adjustment in early childhood: A quantitative genetic approach to studying family processes and child development. *Child Development*, 71, 468-484.

De Groot, J.I, M., Steg, L. (2009). Morality and prosocial behaviour: the role of awareness, responsibility, and norms in the norm activation model. *Journal of Social Psychology*, 149(4), 425-450.

Derlega, V. J., & Grzelak, J. (1979). Appropriateness of self-disclosure. In G. J. Chelune (Ed.), *Self-disclosure: Origins, patterns, and implications of openness in interpersonal relationships* (pp. 151-176). San Francisco: Jossey-Bass.

Doyle, A.B., Connolly, J., & Rivest, L.P. (1980). The effect of playmate familiarity on the social interactions of young children. *Child Development*, 51(1), 217-223.

Edwards, C.P., Tretasco de Guzman, M.R., Brown, J., & Kumru, A. (2006). Children's social behaviours and peer interactions in diverse cultures. In X. Chen, D.

- French., and B.H. Schneider, (Eds.) *Peer-Relationships in Cultural Context* (pp. 23-51). Cambridge NY: Cambridge University Press.
- Eisenberg, N., Cameron, E., Tryon, K., & Dodez, R. (1981). Socialization of prosocial behaviour in the preschool classroom. *Developmental Psychology, 17*, 773-782.
- Eisenberg N, Fabes R.A., Spinrad, T.L. (2006). Prosocial development. In Eisenberg N., & Damon, W (Eds.). *Handbook of child psychology, Volume : Social, emotional, and personality development. 6th edition* (pp. 646-717). Wiley; New York.
- Erikson, E. H. (1963). *Childhood and society, 2nd edition*. New York: Norton.
- Fabes, R.A., Martin, C.L., & Hanish, L.D. (2008). *Children's behaviours and interactions with peers*. In Rubin, K., Bukowski, W. & Laursen, B (Eds.). *Handbook of Peer Interactions, Relationships and Groups*. New York: Guilford Press.
- Farver, J.M., Kim, Y.K., & Lee, Y. (1995). Cultural Differences in Korean- and Anglo-American Preschoolers' Social Interaction and Play Behaviours. *Child Development, 66(4)*, 1088-1099.
- Feiring, C., & Lewis, M. (1991). The development of social networks from early to middle childhood: Gender differences and the relation to school competence. *Sex Roles: A Journal of Research, 25*, 257-53.
- Fujisawa, K. K., Kutsukake, N., & Hasegawa, T. (2008). Reciprocity of prosocial behaviour in Japanese preschool children. *International Journal of Behavioural Development. 32(2)*, 80-97.
- Furman, W., & Bierman, K.L. (1983). Developmental changes in young children's conceptions of friendship. *Child Development, 54*, 549-556.

- Gaskins, S. (2000). Children's daily activities in a Mayan village: A culturally grounded description. *Journal of Cross Cultural Research*, 34(4), 375-389.
- Greenfield, P.M., Suzuki, L.K., Rothstein-Fisch, C. (2006). Cultural pathways through human development. In K.A. Renninger & I.E. Sigel. (Eds.) *Handbook of child psychology: Vol. 4. Child Psychology in practice* (pp. 655-699). New York: Wiley.
- Grusec, J. E., Davidov, M., & Lundell, L. (2004). *Prosocial and helping behaviour*. In P. K. Smith & C. H. Hart (Eds.) *Blackwell Handbook of Childhood Social Development*, 457-474: Blackwell Publishing.
- Hay, D.F., Caplan, M., & Nash, A. (2008). *The beginnings of peer relations*. In Rubin, K., Bukowski, W. & Laursen, B (Eds.). *Handbook of Peer Interactions, Relationships and Groups*. (pp. 3-10). New York: Guilford Press.
- Hartup, W. W. (2008). *Critical issues and theoretical viewpoints*. In Rubin, K., Bukowski, W. & Laursen, B (Eds.). *Handbook of Peer Interactions, Relationships and Groups*. New York: Guilford Press.
- Hartup, W. W. (1992). *Having friends, making friends, and keeping friends: Relationships as educational contexts*. ERIC Digest. Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education.
- Hartup, W.W., & Stevens, N. (1997). Friendships and adaptation in the life course. *Psychological Bulletin*, 121, 355-370.
- Hinde, R.A. (1987). *Individuals, relationships and culture*. Cambridge: Cambridge University Press.

- Hirshfeld-Becker, D. R., Biederman, J., & Rosenbaum, J. F. (2004). Behavioural inhibition. In T. L. Morris & J. S. March (Eds.), *Anxiety disorders in children and adolescents* (2nd ed.) (pp. 27–58). New York: Guilford Press.
- Ho, D.Y.F. (1986). Chinese patterns of socialization: A critical review. In M.H. Bond (Ed.), *The psychology of the Chinese people* (pp. 1-37). Oxford, England: Oxford University Press.
- Ji, L., Peng, K., & Nisbett, R. E. (2000). Culture, control, and perception of relationships in the environment. *Journal of Personality and Social Psychology*, 78, 943-955.
- Kagan, J. (1999). The concept of behavioural inhibition. In L.A. Schmidt & J. Schulkin (Eds.), *Extreme fear, shyness and social phobia* (pp. 3-13). Oxford: Oxford University Press.
- Levitt, M.J., Weber, R.A., Clark, M.C., & McDonnell, P. (1985). Reciprocity of exchange in toddler sharing behaviour. *Developmental Psychology*, 21, 122–123.
- Katz, L. G., & McClellan, D. E. (1997). *Fostering children's social competence: The teacher's role*. Washington, DC: National Association for the Education of Young Children.
- Keller, M. (2004). Self in relationship. In D. K. Lapsley & D. Narvaez (Eds.), *Morality, self, and identity: Essays in honor of Augusto Blasi* (pp. 269–300). Mahwah, NJ: Erlbaum.
- Lansford, J. E., & Parker, J. G. (1999). Children's interactions in triads: Behavioural profiles and effects of gender and patterns of friendships among members. *Developmental Psychology*, 35, 80-93.



- Larson, R., & Richards, M. H. (1991). Daily companionship in late childhood and early adolescence: Changing developmental contexts. *Child Development*, 62, 284–300.
- Lee, M. R., Okazaki, S., & Yoo, H. C. (2006). Frequency and intensity of social anxiety in Asian Americans and European Americans. *Cultural Diversity and Ethnic Minority Psychology*, 12, 291-305.
- Maccoby, E.E. (2002). The intersection of nature and socialization in childhood gender development. In C. von Hofsten & L. Backman (Eds.), *Psychology at the turn of the millennium, Volume 2: Social, development, and clinical perspectives* (pp. 37-52). Florence, KY: Routledge.
- Maccoby, E.E. (2000). Parenting and its effects on children: On reading and misreading behaviour genetics. *Annual Review of Psychology*, 51, 1-27.
- Maccoby, E.E., & Martin, C.N. (1983). Socialization in the context of the family: Parent-child interaction. In E.M. Hetherington (Ed.), *Handbook of child psychology: Vol. 4. Socialization, personality and social development* (pp. 1-102). New York: Wiley.
- Markus, H. R., & Kitayama, S. (1991). Cultural variation in the self-concept. In G. R. Goethals & J. Strauss (Eds.), *Multidisciplinary perspectives on the self* (pp. 18-48). New York: Springer-Verlag.
- Markus, H. R., Mullally, P. & Kitayama, S. (1997). Selfways: Diversity in modes of cultural participation. In U. Neisser & D. Jopling (Eds.), *The conceptual self in context: Culture, experience, self-understanding*. (pp. 13-61). Cambridge: Cambridge University Press.

- Masten, A.S., Coatsworth, J.D., Neemann, J., Gest, S.D., Tellegen, A., and Garmezy, N. (1995). The structure and coherence of competence from childhood through adolescence. *Child Development*, *66*(6), 1635-1659.
- McHale, S.M., Crouter, A.C., and Whiteman, S.D. (2003). The Family Contexts of Gender Development in Childhood and Adolescence. *Social Development*, *12*(1), 125-148.
- Miller, J. G. (1994). Cultural psychology: Bridging disciplinary boundaries in understanding the cultural grounding of self. In P. K. Bock (Ed.), *Handbook of psychological anthropology*. (pp. 139-170). Westport, CT: Greenwood Publishing Group.
- Newcomb, A.F., & Bagwell, C.L. (1995). Children's friendship relations: A meta-analytic review. *Psychological Bulletin*, *117*, 306-347.
- Newcomb, A.F., & Bagwell, C.L. (1996). The developmental significance of children's friendship relations. In W.M. Bukowski, A.F. Newcomb, & W.W. Hartup (Eds.). *The company they keep: Friendship in childhood and adolescence*. Cambridge: Cambridge University. pp. 289-321.
- Noack, P., and Puschner, B. (1999). Differential trajectories of parent-child relationships and psychosocial adjustment in adolescents. *Journal of Adolescence*, *22*, 795-804.
- Parker, J. G., & Asher, S. R. (1993). Friendship and friendship quality in middle childhood: Links with peer group acceptance and feelings of loneliness and social dissatisfaction. *Developmental Psychology*, *29*, 611-621.

- Papini, D. R., Farmer, F. F., Clark, S. M., Micka, J. C., & Barnett, J. K. (1990). Early adolescent age and gender differences in patterns of emotional self-disclosure to parents and friends. *Adolescence*, 25, 959-976.
- Piaget, J. (1932). *The Moral Judgement of the Child*. NY: Harcourt, Brace Jovanovich.
- Peng, K., Nisbett, R. E., & Wong, N. Y. (1997). Validity problems comparing values across cultures and possible solutions. *Psychological Methods*, 2, 329-344.
- Rubin, K.H., Burgess K.B. & Stewart, S. (2003). *Social withdrawal and inhibition in childhood*. In Mash, E. & Barkley, R. (Eds.). *Child psychopathology, 2nd edition*. New York: Guilford. pp.372-406.
- Rubin, K.H., Bukowski, W., & Parker, J. (2006). Peer interactions, relationships, and groups. In W. Damon, & R.M. Lerner (Eds.), *Handbook of child psychology* (pp. 571-645). Hoboken, N.J.: John Wiley & Sons.
- Rubin, K.H., Coplan, R., Chen, X., Buskirk, A., & Wojslawowicz, J.C. (2005). Peer relationships in childhood. In M. A. Bornstein & M. E. Lamb (Eds.), *Developmental Psychology: An Advanced Textbook* (5th edition). Hillsdale, N.J.: Erlbaum.
- Rubin KH, Rose-Krasnor L. 1992. Interpersonal problem-solving and social competence in children. In VB Van Hasselt & M. Hersen (Eds.), *Handbook of Social Development: A Lifespan Perspective*. New York: Plenum. pp. 283–323.
- Savin-Williams, R. C., & Berndt, T.J. (1990). Friendships and peer relations during adolescence. In S. S. Feldman & G. R. Elliot (Eds.), *At the Threshold: The Developing Adolescent*. Cambridge: Harvard University Press. pp. 277-307.

- Schneider, B.H., Fonzi, A., & Tani, F. (1997). A cross-cultural exploration of the stability of children's friendships and the predictors of their continuation. *Social Development, 6*, 322-339.
- Scourfield, J., John, B., Martin, N., & McGuffin, P. (2004). The development of prosocial behaviour in children: A twin study. *Journal of Child Psychology and Psychiatry, 45*, 927-935.
- Sharabany, R., Gershoni, R., & Hofman, J. E. (1981). Girlfriend, boyfriend: Age and sex differences in intimate friendship. *Developmental Psychology, 17*, 800-808.
- Shi, T. (2000). Cultural Values and Democracy in the People's Republic of China. *China Quarterly, 162*, 540-559.
- Simpkins S. D., & Parke R. D. (2001) The relations between parental friendships and children's friendships: Self-report and observational analysis. *Child Development, 72*, 569-582.
- Stevenson, H.W. (1991). The development of prosocial behaviour in large-scale collective societies: China and Japan. In R.A. Hinde & J. Groebel (Eds.), *Cooperation and prosocial behaviour* (pp. 89-105). Cambridge: Cambridge University Press.
- Tietjen, A.M. (2006). Cultural influences on peer relations: An ecological perspective. In X. Chen, D. French, & B. Schneider (Eds.), *Peer relationships in cultural context* (pp.52-74). New York: Cambridge University Press.
- Ting-Tomey, S. (1991). Intimacy expression in three cultures: France, Japan and the United States. *International Journal of Intercultural Relations, 15*, 29-46.
- Tong, J. (2003). The Gender Gap in Political Culture and Participation in China.

*Communist and Post-Communist Studies*, 36, 131-50.

van Brakel, A.M. L., & Muris, P. (2006). A brief scale for measuring “Behavioural Inhibition to the Unfamiliar” in children. *Journal of Psychopathology and Behavioural Assessment*, 28, (2), 79-84.

Vygotsky, L. S. (1978). M. Cole, V. John-Steiner, S. Scribner & E. Souberman (Eds.), *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Waldrip, A.M., Malcolm, K.T., Jensen-Campbell, L.A. (2008). With a little help from your friends: The importance of high-quality friendships on early adolescent adjustment. *Social Development*, 17(4), 832-852.

Wang, A., Stevens, B., Chen, P., & Qian, M. (1999). The Impact of Family Socialization Practices on Children's Socialization in China. *Journal of Research in Childhood Education*, 14, 91-102.

Waters, E., & Sroufe, L.A. (1983). Social competence as a developmental construct. *Developmental Review*, 3(1), 79-97.

Whiting, B.B., & Edwards, C. P. (1988). *Children of different worlds*. Cambridge, MA: Harvard University Press.

Woolfolk, Anita. (2004). *Educational Psychology*. (9th ed). Boston: Allyn and Bacon.

Zahn-Waxler, C., Schiro, K., Robinson, J. L., Emde, R. N., & Schmitz, S. (2001). Empathy and prosocial patterns in young MZ and DZ twins: Development and genetic and environmental influences. In R. N. Emde & J. K. Hewitt (Eds.), *Infancy to early childhood: Genetic and environmental influences on developmental change* (pp. 141–162). New York: Oxford University Press.

## Appendix A

### Early Behavioural Characteristics, Relationships and Socio-emotional Adjustment Study: Information Letter and Consent Form

Dear Parents:

Your child and you have participated in a project concerning children's social behaviours and peer interactions. We invite you to participate in *another* follow up study. The study will involve completion of some questionnaires by parents and a visit of the child to the Children's Peer Relationships Laboratory (located on the second floor, Westminster Hall, UWO) at the Department of Psychology, University of Western Ontario.

Essentially, we are investigating how early behavioural characteristics, parenting practices, family conditions in the early years may predict social behaviours and peer interactions in childhood. We are interested in whether temperament and socialization are associated with the child's social competence and functioning. A parallel study is currently being conducted in China. We will also be interested in whether there are cross-cultural differences between Canadian and Chinese children in their social behaviours.

During the visit to the laboratory, we will be observing and videotaping each participating child while he/she is playing with one of his friends and two other same-age playmates. The children will be in a room with many toys, a table and a few chairs. For the first 15 minutes, the children will be free to play with a variety of toys present in the room. The experimenter will enter the room and ask the children to pick up the toys and put them into baskets. During the experiment, there will be some brief episodes in which the experimenter displays need for help.

In the next session, the experimenter will ask the children to work together on a project, building a "village" as shown on a paper with Lego blocks (6 min.). Then, they will be asked to discuss some issues (example: "What is the most important thing as a goal for you next year? How do you plan to achieve it?") and to plan a weekend holiday with friend (e.g., activities, destinations, schedule) (15 min.). Next, they will be free to play with all the toys again, for another 10 minutes, and a special toy called "spaceship", for 3 minutes. Following the paradigm, we will have a brief individual interview (about 2 minutes) about his/her impression of peers in the group. Then, each child will be asked to complete questionnaires concerning social relationships, social and emotional adjustment, and school attitudes. The visit will last for about a total of 75 minutes.

We are also interested in how your child behaves in the school. We will ask your child's teacher to complete a questionnaire about the child's school performance and social behaviours (see attached copy).

Parents of the child who are interested in the study will complete a set of questionnaires later at home concerning parenting practices, the child's social behaviours and family functioning. It will take about an hour to complete these questionnaires.

In appreciation for your contribution to the study and to compensate you for research-related expenses, you will be given \$60.00. If you have any questions whatsoever about the project, please feel free to get in touch with Rachel Lehcier-Kimel at 661-2111, ext. . You may chose to participate in all or any of the laboratory and school sections of the study.

All information collected during the course of this study will be kept in secure places and remain confidential. The videotapes and other research material will be kept for further use in the future follow-up studies. The information will be identified by subject number only. If the results of the study are published, your name will not be used and no information that discloses your identity will be released or published. Participation in the study is voluntary. There are no known risks to participating in this study. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time. If you have any questions about the conduct of this study or your rights as a research participant, you may contact the Director, Office of Research Ethics, The University of Western Ontario, 519-661-3036, or email at: [ethics@uwo.ca](mailto:ethics@uwo.ca).

Yours sincerely,

---

Xinyin Chen, Ph. D.  
Professor

---

Rachel Lehcier-Kimel, MSc Candidate  
Project Coordinator

Early Behavioural Characteristics, Relationships and Socio-emotional Adjustment: From  
Toddlerhood to Early Adolescence

*Consent Form*

I have read the Letter of Information, have had the nature of study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Consent form for child:

I. I give my consent to have my child, \_\_\_\_\_, participate in the laboratory section of this study.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

II. I give my consent to have my child, \_\_\_\_\_, rated by the teacher,  
Mr(s) \_\_\_\_\_, at \_\_\_\_\_.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Consent form for mother:

I agree to participate in the study.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Consent form for father:

I agree to participate in the study.



\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Child consent form:

I agree to participate in the study.

\_\_\_\_\_  
Child signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature of person obtaining informed consent

## Appendix B

### Lab observation of 14-year-olds PROTOCOL

#### ITEMS FOR USE:

1. A square table
2. Four chairs
3. Toys
4. Stack of journals (for Helping session #1)
5. Question sheets (for Discussion session)
6. Space shuttle (with the model for the Construction session)
7. Special toy (remote controlled helicopter) and extra batteries
8. Box(es) (for cleanup sessions)
9. Drinks and treats for children
10. Coffee and snacks for parents
11. Questionnaires for mom and dad
12. Child self-report questionnaires for children
13. Interview recording sheet for children

#### INITIAL SET-UP OF PLAYROOM:

1. Toys are spread out in room (use identical pattern for each session)
2. Move toy bin, table, and [chairs? to be decided later] out of room

#### PREPARATION:

##### *Participants*

Four children of same sex are invited to come to the university laboratory (two children from the original sample, and one best friend of each child from the school or neighborhood). The child from the original sample is “focal” child, and the focal child’s friend is “friend” (F). If the friend is not the same friend the focal child brought in at age eleven, record the ID number as FF.

Contact children’s parents 2 weeks before the visit. At least 5 phone calls need to be made to arrange the two friend dyads come to the lab.

#### CALLING PROTOCOL:

1. *Initial contact with parents of children who participated in the previous study*, ask whether they are interested in attending the follow-up study, who is the child’s friend, and whether they can contact the friend’s family and invite the friend to come (see separate instructions). Ask about the tentative dates that are appropriate for the visit.

2. *2 days after the first contact, call the focal child's parents again* to make sure if they've talked with the friend's family. If the friend is willing to come, ask for contact information of the friend's family.
3. *Call the friend's parents* to confirm the child's participation. Ask for their mailing address to send the consent form. If parent of the "friend" does not plan to come to the University lab, the parent of the focal child may bring both children. In that case, the "friend" should bring the consent form when he/she comes to the lab.
4. a) *Ask about the schedule*: It may take several phone calls to find a time for the visit of all 4 children.  
b) *Ask whether they are interested* in completing some questionnaires about child behaviours and family environment.
5. *2 days before the visit, call both the focal child's family and the friend's family* to make sure they are coming on time and to confirm they know the date/time and location of Westminster Hall.

\* Remind the friend's parents to sign the consent form and ask the child or focal child's parent to bring it to the lab.

\* Give directions about how to get to the university, where to park and where to meet (experimenter will meet them outside the front doors of Westminster Hall and will give them a parking pass).

ON THE DAY OF THE VISIT: Everyone on research team scheduled should arrive 30-45 minutes before participants in order to set up the for the observation session.

Prepare all the items for use:

- A) Using files from the file folder beside the door in Room 228, create a file with each participant's number written on it (you can see what the participant numbers are by logging on to the Google calendar from the lab computer in Room 228).
- B) On a blank sheet of paper write all 4 participant numbers down.
- C) Place the following (from the shelf in Room 228) in each child's file :
  - 1) Child interview sheet
  - 2) Child questionnaire

\*Make sure to write each participant's number at the top of the first page of each measure

- C) Put mother questionnaires and father questionnaires clipboards (on shelf in Room 228). You will give these to the parents who wait during the observation to fill out.

- D) From Room 234 (use the keys on top of the file folder in room 228 for access):
- Get coffee, filter, coffee maker, cookies, candies, styrofoam cups, spoons, and napkins for the parents who will wait while the participation occurs and set it up on the large table in the waiting area at the end of the hall.
  - Make coffee (get water from sink in bathroom outside the double doors and make sure you take your card so you can get back in afterwards)
  - Get 4 oatmeal cookies (on top of the shelves on the left side of the room) and four individual packs of strawberry chewy fruit candies, one container of juice and 4 small plastic cups, and leave them in Room 230 on the table for when it is snack time for participants and the experimenter needs them.
- E) Set up the playroom with toys laid out:
- Take all the toys from the blue bin and lay them out in the center of the room according to the picture (which is on the table in Room 230 next to the remote helicopter).
  - Take the empty blue bin and wooden table and leave it in the hallway outside Room 232.
- F) Check the audio and video equipment in Room 230 (turn the computer, monitor, video recording on according to the instruction sheet taped up on the wall).
- G) Take the Special toy (helicopter) and charge it in Room 228 using a free outlet and when it is charged put it back in Room 230. Also, find the “question cards” for the discussion session, and the “space shuttle” model and the pieces for the cooperation session.
- H) 20 minutes before scheduled time, one person should go downstairs and wait for participants to arrive (make sure they have their student card for access to the lab again)

WHEN PARTICIPANTS ARRIVE:

1. Parents and children are brought from the parking lot to the lab. Kids are asked about using bathroom. If they have to go, they should go prior to the start of the observation session.
2. Take a blank piece of paper and marker with you (which you already have written participants numbers on) and ask all children for their names to write next to their participant numbers (the numbers that have FF are the friends so you can ask who is a friend of a child who participated in this study before and you will know whose names to write next to the participant numbers ending in FF). Then write a brief description of what each child is wearing (this sheet should then be given to Main Experimenter to hold up to the camera BEFORE THE OBSERVATION BEGINS). The experimenter should then check with the person in charge of the camera in room 230 to make sure the sheet of paper was clearly seen on camera.

3. Take the mailing address sheet from the bulletin board in Room 228 and ask each parent to write in their mailing address (so we can mail them payments later). If a child is there without their parent (i.e. their friend's parent drove them to the lab), then ask the child for the mailing address and if they don't know it, ask for their phone number so we can call and get it from the parents later.
4. Parents are shown the waiting area to sit and have coffee/snacks and given instructions about the sequence of the study, children's activities, and completing questionnaires. Parents are then given questionnaires to fill out and pens (by either Experimenter 2 or 3, not the Main Experimenter who will interact with the children). Ask which parents are not present for each child so that we know what needs to be sent home and then mailed back to us (i.e. just mother questionnaire, just father questionnaire, or both mother and father). Depending on what needs to be sent home for each child, go to Room 228 and get either a double stamped envelope that has 1 mother and 1 father questionnaire or a single stamped envelope that has either 1 mother or 1 father questionnaire only (and depending on what is needed make sure you are giving the correct one ... look at what is inside of the envelope to see if it is just mother or just father questionnaire).
5. Experimenter takes kids to the play room. Introduce children to each other. If it's too noisy, ask children to be quiet and listen.

### LAB SESSIONS

Follow the instructions for each session as strictly as possible. Do not alter/modify the instruction. If something unusual happens or any child asks questions, respond according to your judgment. But try NOT to provide any unnecessary extra information.

Before the participants enter the room, the Experimenter gives the following instructions in the hallway with the door open:

OK everybody, my name is [*say your name*]. As you know, for scientific research, we need to videotape all activities in this room and then conduct analysis on the activities. The analysis will be about the whole sample, that is, all teenagers in the study, not just your group. So we will put all the data together, and get an idea about what teenagers at your age typically do when they are with other teenagers. We will not analyze any individual person. So, you just need to do as you usually do. There are 2 cameras in the room but don't worry about it. Also, try not to look at the cameras all the time, and please don't touch them. Again, just do what you usually do, OK?

Make sure that one person in the main camera room is in charge of keeping time for each of the sessions.

#### 1) FREE PLAY SESSION #1 (15 minutes)

Experimenter: This is the playroom. All these toys are for you all to play with! You can play with whatever you want, but you should stay in this room. I am going out now, but

I'll be back in a few minutes with something else for us to do. Are you ready guys? OK, have fun playing!

*Reasons for experimenter to enter or intervene:*

1. washroom break
2. children are physically aggressive
3. children step out of the room

2) CLEAN UP SESSION #1 (3 minutes)

*When the free play is over, the experimenter brings the basket to the middle of the room. Put the basket (if two, put them close to each other for now) on the ground first.*

Experimenter: *(Stand in the corner) OK, did you all have fun playing with the toys? Now, it's clean up time! I want you to put all of the toys in this basket/box. (Adjust the basket for the toys, so it is in the center of the room; then leave the room.)*

*If toys are not cleaned up by the end of the clean up period, the experimenter goes in again and says "OK, Let me put these toys into the basket", and then finish it.*

*If the toys are cleaned up before 3 minutes, the experimenter enters room after 3 minute and say:*

"OK, is that everything? Looks good."

3) HELPING SESSION #1 (1 minute)

*Before moving the basket of toys out, the Assistant enters the room and tell the Experimenter:*

Assistant: *"(say name of experimenter), "Dr. Chen wants you to take the journals to his office." [Journals should be on the floor before the study, not on the bookshelf]*

Experimenter: *"When does he need them?"*

Assistant: *"Now, he needs them now. He is in his office. Please do it as soon as possible."*

Experimenter: *Starts to move the books and struggles. In about 10 seconds, "Wow, these journals are heavy". If any children come to help, tell them to put the journals outside the door. "Just leave them here. They are too heavy. I will ask other people to do it later. Let's continue to do our activities in the room".*

4) DISCUSSION SESSION (15 minutes)

Experimenter: "Now we're going to do something different! (*set up the chairs in a square shape*). First, I'd like everyone to sit on the chairs here (*arrange two friends so that they sit next to each other, and the two friend pairs face each other*). (Child's name), could you sit here (*point to chair 1*, and (friend's name), could you sit here (*point to the chair close to chair 1*). Okay, everyone, now I'd like to give you some questions to discuss. We understand that people can have different opinions on the same thing. People can think independently and may have thoughts different from other teenagers and adults. It is normal to have opinions different from others. And it's important to share your ideas with others." (*Give each child a copy of the question sheet with question 1 on it*) "Here is the first question I want you to discuss. (*Read the instructions, vignette (question) and ask them if they have any questions. Emphasize that it is not a test, there are no right or wrong answers, we are interested to see their opinions.*) I'll come back in a few minutes and then ask you to tell me the results of your discussion about this question."

*After 4 minutes, the experimenter comes back in the room, "How was your discussion? Can anyone tell me the results of your discussion?" After the first child talks, ask "Does anyone else want to add something?" After the second child talks, if no one volunteers to add, stop.*

*If no one wants to talk, the experimenter asks "Who would like to tell me the results of your discussion?", "Would anybody like to tell me?", look at every child and ask "Who would like to tell me?". If still no one talks, pick any of them, "xxxx, could you tell me what you talked about this question?"*

"Ok, that's great. Here is the second question." *Give each child a copy of the question sheet with question 2 on it. Read the question and ask them if they have any questions. "I'll come back in a few minutes and then ask you to tell me the result."*

*Repeat this procedure the last question is finished.*

*After last question session is over:*

"That's great. Thanks. Nice discussions!" (*Remove all the discussion sheets before starting next session*)

Note. 1) *If there is no discussion at all for 2 minutes, the experimenter enters and says "You should start to discuss about this question. I will be back to ask you about the results".*

2) *If children finish the discussion before 4 minutes, knock on the door and say "You should discuss this question a little more so you can tell me better results later".*

3) *If any child asks how long their discussion can be, tell them "about 4-5 minutes".*

Topics for Discussion Session:

1. Pretend that you are going to spend a weekend together. Assuming you have unlimited amount of money to spend (as much as you want) and you can do whatever you want to do, use your imagination to plan everything from Friday night until Sunday afternoon. While thinking about your weekend, you may want to consider all the details including activities and things like where you'll go, where you'll stay, how you'll get around and how you'll get food.
2. What is the most important thing as a goal for you next year? Is there anything you really want to do? How do you plan to do it?
3. Have you had any disagreement or conflict with another person in school recently? How did it start? What was the disagreement or conflict about? How did you solve it? How do you think that it should have been solved?

5) SPACE SHUTTLE CONSTRUCTION SESSION (6 minutes)

Before the Discussion is over, the Experimenter and the Assistant move the table by the door outside. When this Construction session begins, the Experimenter moves the table to the middle of the room. During the process, try to do it a little slowly and display some difficulty in moving the table.

Experimenter: *(After table and chairs have been set up, ask friends to sit opposite to each other)* OK, ready everyone? The next activity is called Space Shuttle Construction. Here's a model of the shuttle. I'd like you to work together to make a shuttle just like this one *(show the model, which will remain in the room during this session)*. I just need one. So, I want you to work together and make just one for me. I'll be back in a few minutes *(Leave room)*. *[Leave the model but do not leave the Manual in the room]*

*6 minutes later, the experimenter enters, "How are you doing? Let's just stop here, and let me see what you got". Then take whatever the children built, hold it up and let the camera record the result. "That's great. Let's do something else now".*

*If children want to continue, say: "We need to do something else now. I will take this Space Shuttle out for now but you can continue to do it later if you want".*

7) FREE PLAY SESSION #2 (10 minutes)

Experimenter: *(Remove Space Shuttle materials from room. Move table and chairs to the corner and bring the toys back to the room)*. "Now, you can play with these toys again. *(Empty the toy box in the center of the room)*. Okay, here are your toys! Have fun – I'll be back soon".



8) CLEAN UP SESSION #2 (3 minutes)

Experimenter: “OK, it’s clean up time again! I want you to put everything into this box. I will be back soon.” (*Leave room*).

*If toys are not cleaned up by the end of the period, the experimenter enters and says “OK, Let me put these toys into the box”, and then finish it. If the toys are cleaned up before 3 minutes, the experimenter enters room and brings the toys out. Start the next session.*

\*Turn on the remote control and helicopter (using ON/OFF switch on bottom of the toy) so that it is warmed up for the next session.

9) SPECIAL TOY SESSION (5 minutes)

Experimenter: (*Take box out of room when toys are cleaned up*). “Okay, I have one last thing for you to do in this room. I have a really cool toy for you to play with! It’s a really fun toy, and I thought that you would really like to play with it. (Bring the toy into the room). This is a remote helicopter. Let me show you how to play with it.”

“Now, could you please stand in a row” (*ask children to line up in a row against one wall while you demonstrate how toy works*).

“To fly it properly and safely, you should stay away from it. Do not touch it with your hand or fingers because it can hurt you.”

“There are two buttons on the remote control. The left one is to control the speed and the height. When you push this button forward, it will fly faster and higher. When you push the button backward, it will fly slower, lower, and stop. Make sure to push this button very slowly. It may take a while to start the helicopter, so be patient. The button on the right tells which direction it will fly. Again, push the button slowly.”

“OK? Any questions?”

“OK, have fun playing! I will be back in 5 minutes”. *Then put the toy on the ground.*

*(After 5 minutes go in with drinks/snacks)* “Did you all have fun? Here are some drinks and snacks for you.” “Has anybody not played with the toy?” “Do you want to play with it for a while?” (*let the child play for 1-2 minutes if they want, keep videotaping*)

EXPERIMENT ENDS: (*Length of entire experiment is approximately 55 minutes*)

- The camera person stops the videotaping, takes out the DVD, and writes children’s IDs and names on the DVD.
- Rename the video file on the computer to “14yrB(orG)X(group#) – 2009XX(month)XX(date)” (e.g., 14yrB1-20090125).
- The computer file should be in “D:\14 yr olds video”, but may be in the default folder “Documents and settings\All Users\Document\Noldus\The Observer XT\Media” if you forgot to select the folder at the beginning.

- Make a copy of the file using “copy and paste” to the external hard drive SimpleDrive(R:)\13 yr olds video-London.

Experimenter 1 and 2 (assistant): *Lead two children to another room (one in Room 228 and one in Room 232) to complete interviews and leave the other two with questionnaires to fill out on table in observation/play room.*

- Separate friends (leave 2 non friends in room 232 to fill out questionnaires while Experimenters 1 and 2 take one child each to Rooms 234a and 228 to do the interview.
- Experimenter 1 and 2 record interview answers on the “recording sheet” only (not the sociometric sheet attached.
- Then switch order - take 2 kids who just completed interviews back into room 232 to fill out questionnaires. Take the two kids who did the questionnaires first to rooms 228 and 234a to do interviews – once they have been interviewed, have them stay in their respective rooms to complete the rest of their questionnaires. When participants have completed the questionnaires, bring them back to the waiting area.

\*Thank the parents and participants for coming in, and have someone escort them back downstairs.

\*Make sure the kids or spouses have the questionnaires to take home to their parents who were not present. They can mail them back when they are done.

\* Put all left over drinks and snacks neatly back in Room 234 and dump extra coffee out in sink in bathroom.

\* Make sure all doors are locked (main set of master keys to be put back in room 228) and make sure the lock on the door is also manually pressed (so all doors should be double locked).

## Appendix C

## Friendship Interaction Coding

BACKGROUND INFORMATION

- This coding scheme does not reflect the degree or extent of behaviours. In other words, behaviours are not coded based on the amount or level that they are expressed (i.e. such as a little, moderate amount, or a lot). Rather, behaviours are coded only when they are very salient and dominate the time interval in question. We are using time sampling with 30 second intervals.
- This coding scheme reflects two aspects of children's interactions – a behavioural and an affective component. Each aspect of the interaction must be recorded. (e.g., Children are attempting to fix a broken toy but they are doing so very happily, they're smiling and laughing every time the toy falls apart – Problem Solving would be the behaviour code and Positive Affect would be the affect code). In other words, every 30 second time interval is double coded for each subject for both the behaviour and the affect separately.

STEPS TO TAKE WHEN CODING:

- 1) Decide dominant *level of interaction* for time interval: dyad, triad or group.
  - If two levels are both seen: go with the most dominant one (i.e. if both triad and group are seen but the triad interaction dominates the time interval in question and is most obvious/salient then code triad).
- 2) Decide if the interaction is *a) Reciprocal* (all subjects involved are doing the same behaviour) OR *b) Complimentary* (subjects are involved with each other but doing different behaviours).
  - If one or more subjects is displaying a passive or inactive role (i.e. watching or listening then code the behaviour as complimentary)
  - The only time a subject would not be coded is if they are completely uninvolved (i.e. off in a corner not interacting in any way with any other subject, playing by themselves).
- 3) Decide the behaviour code for each subject (if the interaction is complimentary then each subject involved in the interaction gets the behaviour code of "complimentary". If the interaction is reciprocal, then code for each subject what behaviour is displayed (i.e. all subjects involved either get cooperative play or expression of opinions or discussion of 3<sup>rd</sup> person topic code, etc.)
- 4) Decide the affect code for each subject (positive, negative or neutral). If different subjects involved in the interaction display different affect then code mixed-positive, mixed-negative or mixed-neutral for each. The "mixed" part tells us that in the interaction different subjects show different affect and the "positive, negative or neutral" after the

“-tells us what affect each particular subject is displaying.

## BEHAVIOUR CODES

### 1. Cooperative Play

This code is broad and is intended to capture the more general aspect of children's interactions. It involves a more neutral form of interaction. Kids are just playing, and engaged in activity together.

e.g., “Do you want to play this?” “No, thank you.”  
Children are throwing ball at each other.

### 2. Prosocial/Helping behaviours

Children appear to be getting along well with each other, they are cooperative in their interactions; the code refers to explicitly pleasant, nice and considerate behaviour shown toward each other. Children are respectful of each other, they display prosocial and helpful behaviours; they also make kind and polite requests.

e.g., “Would you like to play this game with me?”  
“Could you please pass that over?”  
Helping someone build something.  
Complying to a request for help kindly and willingly.

### 3. Polite/Positive comment/Praise

This code reflects a child giving positive feedback or praise to another child.

e.g. “Good job!”  
“I like your shirt!”  
“That was really smart.”  
“You're really good at that.”

### 4. Personal/Private/Intimate disclosure

This code assesses whether or not children disclose information of a personal or private nature about themselves, especially discussion of personal experience, feelings, family, close relationships etc. The information that the child is sharing revolves around him/herself, it is private and personal.

e.g., Talking about what they did over the weekend.  
Disclosing information on a fight they had with their mother.

5. Discussion of 3<sup>rd</sup> Person Topic

This code reflects discussion of a topic that is not focused on the individual, it does not include anything personal or private; rather it is very objective. Here, children are removed from the situation in that they are not involved in the events that they discuss.

e.g., Chatting about the latest Britney Spears news.

Chatting about someone they know in school.

Talking about the camera in the room, the experimenter.

Talking about a toy objectively (not how much they like or dislike it).

6. Expression of opinions

This code assesses the opinions and positions that children display. There is no negative connotation in this code, in other words, children are not having an argument or fighting about something. Instead, they are having a friendly discussion where they are expressing their views and sharing their opinions and thoughts.

e.g., "I like that movie too, but my favorite is Happy Feet."

"Why don't we try doing it like this?" (Child suggests a different way to play a game.)

Note: Debates depend on the affect within which the debate occurs. If hostile and children clearly upset, then conflict, if friendly & playful, then expression of opinion.

7. Problem Solving/Dissolving Issue

This code is contingent upon the fact that a problem or issue has arose and children are attempting to resolve it. So first, a problem must exist. Next, this code would apply if children are clearly trying to come up with a solution, whether it's discussing it with each other, or trying out different ways to fix the broken toy. With this code, the focus is on finding a solution to the problem at hand.

8. Negative Involvement

This code reflects children not connecting with one another and instead are displaying negative attitudes and behaviours toward one another. During negative involvement, children are not getting along and their interactions are disconnected. Children may also not partake in each other's agenda, they can be rude, intrusive and unresponsive (such as purposely ignoring a request or comment). This code may also include an imbalance in the interaction where one

child continues to dominate the conversation, especially without letting the other child take a turn.

e.g., "Gimme that!" *Grabs toy out of someone else's hand without their consent.*

Interrupting when someone is speaking and not giving them a chance to talk.

"Whatever, that's just stupid."

#### 9. Conflict/Disagreement

This code defines the extent to which the interaction is characterized by conflict, disagreement, or aversive interchanges. Focus is on how conflicted, displeasing, unrewarding, boring, or emotionally distressing the relationship is. This includes negative interchanges such as arguments, disagreeing; behavioural examples include hitting, toy taking. Rejecting bids to play or turning down request will be coded here. Emphasis in this code is on how aversive the action is, so if a child turns down a request bitterly, then it would be coded here, but if the child politely says "No thank you", then it would be coded as positive involvement

e.g., "No, I don't want to do that."

"That's not true, when I tried it, it was different."

Children are arguing about something.

#### 10. Aggression/Hostility

This code reflects any acts of aggression, whether verbal or non-verbal, whether physical or relational.

e.g. Kicking/hitting another child.

Purposely whipping the ball at one of the child.

Purposely excluding someone from playing.

Verbally assaulting someone.

#### 11. Competition

The competitive behaviour must be very clear and salient. For instance, children must make comments to indicate that they are engaging in a competition of some sort. The competitive behaviour between the children must be very explicit and noticeable. If children are merely playing a game (tossing ball back and forth), then *not* competition, rather, code as cooperative behaviour.

e.g. "I got 2 points you got 1!"

"I'm better than you!"

"I beat you!"

"I win, you lose!"

## 12. Sarcasm/Ridicule

Children make sarcastic remarks or make fun of something/someone. The comment may elicit laughing but the tone is sarcastic or the underlying motive is to ridicule something/someone.

e.g. "Yeah, that is soooo cool." Laughing and rolling eyes.  
"Whatever, she thinks she's the best!"

## AFFECT CODES

### 1. Positive Affect (Verbal & Non Verbal)

This code refers to the explicit display of pleasure and enjoyment. This code includes both non-verbal and verbal aspects. Non-verbal: laughing, smiling, and giggling. Verbal: giving out compliments; expression of happiness and joy.

e.g., "This is fun!"  
"Wow! You're good at that!"

Note: Reason for smiling or laughing must be the same. Ridicule does *not* count as positive affect.

### 2. Negative Affect

This code refers to the explicit display of unhappiness and dissatisfaction. Here, children are clearly not content in their interactions.

e.g., "I don't like you."  
Clear display of unhappiness & uneasiness, child walks away from conversation.

### 3. Neutral Affect

There is no display of specific emotions.

# Table of Contents

Certificate of Examination .....	ii
Abstract .....	iii
Co-Authorship.....	v
Dedication .....	vi
Acknowledgments.....	vii
Table of Contents .....	viii
List of Abbreviations .....	xiii
List of Figures and Schemes .....	xv
List of Tables .....	xxiii
CHAPTER 1. INTRODUCTION .....	1
1.1. Background and Objectives .....	1
1.2. Gold Nanoparticles (Au NPs) .....	4
1.2.1. Historical Perspective of Au NPs.....	4
1.2.2. Optical Properties of Metal NPs.....	5
1.2.2.1. Theory.....	6
1.2.2.2. Experiment .....	13
1.2.3. Biosensing Applications of Au NPs.....	17
1.3. Thesis Overview .....	19
1.4. References.....	22
CHAPTER 2. EXPERIMENTAL TECHNIQUES.....	27
2.1. Measurement of the Contact Angle .....	27
2.2. Scanning Electron Microscopy (SEM) .....	29
2.3. Focused Ion Beam (FIB).....	31
2.4. Atomic Force Microscopy (AFM) .....	32
2.5. Time-of-Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) .....	34
2.6. Rutherford Backscattering Spectrometry (RBS) .....	36



2.7. Tandem Accelerator .....	37
2.8. X-ray Photoelectron Spectroscopy (XPS) .....	39
2.9. Ultraviolet-Visible (UV-Vis) Absorption Spectroscopy .....	41
2.10. Evanescent Waveguide Absorption Spectroscopy (EWAS).....	42
2.11. Ellipsometry .....	44
2.12. Radio Frequency (RF) Sputtering .....	46
2.13. Plasma-Enhanced Chemical Vapour Deposition (PECVD) .....	47
2.14. Self-Assembled Monolayers (SAMs) .....	48
2.15. Organo-Metallic Chemical Vapour Deposition (OMCVD).....	50
2.16. References .....	54

**CHAPTER 3. OCTADECYLTRICHLOROSILANE (OTS): A RESIST FOR OMCVD GOLD NANOPARTICLE GROWTH .....**

3.1. Introduction .....	58
3.2. Experimental Section .....	61
3.2.1. Materials .....	61
3.2.2. OTS SAM Preparation .....	62
3.2.3. MPTS SAM Preparation .....	62
3.2.4. Organo-Metallic Chemical Vapour Deposition (OMCVD) of Gold .....	63
3.2.5. Atomic Force Microscopy (AFM) .....	63
3.2.6. Scanning Electron Microscopy (SEM) .....	64
3.2.7. Ellipsometry .....	64
3.2.8. X-Ray Photoelectron Spectroscopy (XPS) .....	64
3.2.9. Rutherford Backscattering Spectroscopy (RBS).....	65
3.2.10. UV-Vis Spectroscopy.....	65
3.3. Results and Discussion .....	65
3.4. Conclusions.....	79
3.5. Acknowledgements.....	79
3.6. References.....	80

CHAPTER 4. CONTROL OF THE AVERAGE SPACING BETWEEN ALIGNED GOLD NANOPARTICLES BY VARYING THE FIB DOSE .....	83
4.1. Introduction.....	83
4.2. Experimental Section .....	88
4.2.1. Materials.....	88
4.2.2. OTS SAM Preparation .....	88
4.2.3. MPTS SAM Refilling.....	89
4.2.4. Organo-Metallic Chemical Vapour Deposition (OMCVD) of Gold .....	90
4.2.5. Focused Ion Beam (FIB) and Scanning Electron Microscopy (SEM).....	90
4.2.6. Time-of-Flight Secondary Ion Mass Spectroscopy (ToF-SIMS).....	90
4.2.7. Atomic Force Microscopy (AFM) .....	91
4.3. Results and Discussion .....	91
4.4. Conclusions.....	99
4.5. Acknowledgements.....	99
4.6. References.....	100
CHAPTER 5. CONTROL OF DENSITY OF RANDOMLY GROWN OMCVD GOLD NANOPARTICLES BY MEANS OF ION IRRADIATION.....	103
5.1. Introduction.....	103
5.2. Experimental Section .....	107
5.2.1. Materials.....	107
5.2.2. OTS SAM Preparation .....	108
5.2.3. MPTS SAM Refilling.....	109
5.2.4. Organo-Metallic Chemical Vapour Deposition (OMCVD) of Gold .....	109
5.2.5. Contact Angle Measurement.....	109
5.2.6. Tandem Accelerator, Ion Bombardment/Irradiation, and Rutherford Backscattering Spectroscopy (RBS) .....	110
5.2.7. Scanning Electron Microscopy (SEM) .....	110
5.2.8. X-Ray Photoelectron Spectroscopy (XPS) .....	111
5.3. Results and Discussion .....	111
5.4. Conclusions.....	126

5.5. Acknowledgments.....	127
5.6. References.....	127

CHAPTER 6. BINARY MIXTURES OF SH- AND CH<sub>3</sub>-TERMINATED SELF-ASSEMBLED MONOLAYERS TO CONTROL THE AVERAGE SPACING BETWEEN ALIGNED GOLD NANOPARTICLES..... 131

6.1. Introduction.....	131
6.2. Experimental Section.....	133
6.2.1. Materials.....	133
6.2.2. OTS SAM Preparation as a Resist.....	133
6.2.3. Mixed MPTS and OTS SAM Refilling.....	134
6.2.4. Organo-Metallic Chemical Vapour Deposition (OMCVD) of Gold.....	134
6.2.5. Focused Ion Beam (FIB) and Scanning Electron Microscopy (SEM).....	135
6.3. Results and Discussion.....	135
6.4. Conclusions.....	139
6.5. Acknowledgments.....	140
6.6. References.....	140

CHAPTER 7. POLARIZATION-DEPENDENT ABSORPTION OF ALIGNED OMCVD GOLD NANOPARTICLES..... 142

7.1. Introduction.....	142
7.2. Experimental Section.....	144
7.2.1. Materials.....	144
7.2.2. Indium Tin Oxide (ITO) Deposition.....	144
7.2.3. SiO <sub>2</sub> Deposition.....	145
7.2.4. OTS SAM Preparation.....	145
7.2.5. MPTS SAM Preparation.....	146
7.2.6. Organo-Metallic Chemical Vapour Deposition (OMCVD) of Gold.....	146
7.2.7. Focused Ion Beam (FIB) and Scanning Electron Microscopy (SEM).....	146
7.2.8. UV-Visible Spectroscopy.....	147
7.3. Results and Discussion.....	147

7.4. Conclusions.....	152
7.5. Acknowledgments.....	152
7.6. References.....	152
 CHAPTER 8. SUMMARY AND FUTURE DIRECTIONS.....	 154
8.1. Thesis Summary.....	154
8.2. Future Directions .....	157
 APPENDICES .....	 159
Appendix A: Copyright Release for Material Contained within Chapter 1.....	160
Appendix A1: Copyright Permission for Figure 1.3 .....	160
Appendix A2: Copyright Permission for Figure 1.4 and Figure 1.5.....	161
Appendix B: Copyright Release for Material Contained within Chapter 2.....	162
Appendix C: Copyright Release for Material Contained within Chapter 3.....	163
Appendix D: Copyright Release for Material Contained within Chapter 5.....	164
Appendix E: Copyright Release for Material Contained within Chapter 6 .....	165
 CURRICULUM VITAE.....	 166

## List of Abbreviations

a.u.	arbitrary units
AFM	Atomic Force Microscopy
Au	Gold
CVD	Chemical Vapour Deposition
DC	Direct Current
DC	Directional Coupler
DDA	Discrete Dipole Approximation
DT	1-dodecanethiol
ESCA	Electron Spectroscopy for Chemical Analysis
EWAS	Evanescent Waveguide Absorption Spectroscopy
FIB	Focused Ion Beam
ITO	Indium Tin Oxide
LMIS	Liquid Metal Ion Source
LSPR	Localized Surface Plasmon Resonance
Me	Methyl
MPTS or MPTMS	3-mercaptopropyltrimethoxysilane
NND	Nearest Neighbour Distance
NP	Nanoparticle
NPGS	Nanometre Pattern Generation System
OMCVD	Organo-Metallic Chemical Vapour Deposition
OTS	Octadecyltrichlorosilane
PECVD	Plasma Enhanced Chemical Vapour Deposition
PVD	Physical Vapour Deposition
RBS	Rutherford Backscattering Spectroscopy
RF	Radio Frequency
RIU	Refractive Index Unit
SAM	Self Assembled Monolayer
SEM	Scanning Electron Microscopy

SFM	Scanning Force Microscopy
SG	Schott Grünenplan
SIMS	Secondary Ion Mass Spectroscopy
SPM	Scanning Probe Microscopy
SPR	Surface Plasmon Resonance
STM	Scanning Tunnelling Microscopy
TE	Transverse Electric
TIR	Total Internal Reflection
TM	Transverse Magnetic
ToF-SIMS	Time-of-Flight Secondary Ion Mass Spectroscopy
UHV	Ultra High Vacuum
UV-Vis	Ultraviolet-Visible
XPS	X-ray Photoelectron Spectroscopy

## List of Figures and Schemes

<b>Figure 1.1.</b> Number of publication entries in the ISI Web of Knowledge <sup>SM</sup> for the topic ‘gold nanoparticles’ .....	3
<b>Figure 1.2.</b> Illustration of the localized plasmon oscillation in a metal nanosphere. ....	5
<b>Figure 1.3.</b> E-field enhancement contours $ E ^2$ external to Ag NPs with different shapes, including (a) 30-nm radius sphere, (b) oblate spheroid, and (c) truncated tetrahedron. All the volumes are the same as that of a sphere with a radius of 30 nm. $ E ^2$ is normalized such that the incident plane wave field has a unit value. ....	9
<b>Figure 1.4.</b> Theoretically calculated extinction spectra for hemispherical Au NPs with various coating refractive indices by using DDA method. ....	11
<b>Figure 1.5.</b> Theoretically calculated extinction spectra for two hemispherical Au NPs (a) in air and (b) in water with varying interparticle surface-to-surface separations by using DDA method. ....	12
<b>Figure 1.6.</b> (a) Schematic illustration of an EWAS experiment with different polarization directions for randomly grown OMCVD Au NPs on a waveguide; along with measured EWA spectra of (b) bare and (c) coated 40-min OMCVD grown Au NPs with successively changed polarization in 15° steps in air. ....	14
<b>Figure 1.7.</b> Schematic of a two-guide symmetric directional coupler with an edge-to-edge separation of $d$ . The crosstalk region is shaded. ....	15
<b>Figure 1.8.</b> Measured UV-Vis absorption spectra of 35-min grown OMCVD Au NPs, bare and DT SAM coated ( $n=1.46$ ) in air ( $n=1$ ) and in water ( $n=1.33$ ). The propagation direction of the incident light is perpendicular to the surface of glass substrate, with no preferred polarization direction. ....	16

<b>Figure 1.9.</b> SEM images of OMCVD Au NPs grown on a (left) non well-formed and (right) well-formed OTS SAM patterned by FIB-nanolithography. Only the Au NPs within the lines were desired.....	20
<b>Figure 2.1.</b> Contact angle of (a) a sessile drop with surface tension vectors, and an illustration of how a water droplet might form on (b) a hydrophilic and (c) a hydrophobic surface. ....	28
<b>Figure 2.2.</b> Schematic representation of a scanning electron microscope (SEM). ....	30
<b>Figure 2.3.</b> Schematic diagram of (a) a liquid-metal ion source (LMIS) found in FIB systems, and (b) a dual-beam FIB/SEM configuration.....	31
<b>Figure 2.4.</b> Schematic diagram of the operation of an AFM. The piezo crystal and the oscillator are only needed for tapping mode operation.....	33
<b>Figure 2.5.</b> (a) Schematic representation of the elastic collision between an energetic particle of mass $M_1$ and energy $E_0$ and the target atom of mass $M_2$ which is initially at rest. After the collision, the energies become $E_1$ and $E_2$ with positive scattering angles of $\theta$ and $\phi$ for the projectile and target atom, respectively. (b) Schematic of the RBS experimental setup. ....	36
<b>Figure 2.6.</b> Schematic diagram of (a) single-stage and (b) tandem (two-stage) accelerator. For example, the final energy of a singly charged ion in the UWO's tandem accelerator at its maximum terminal voltage (1.7 MV) can be 3.4 MeV, while the terminal voltage of a single-stage accelerator should be 3.4 MV for the same final energy. ....	38
<b>Figure 2.7.</b> Schematic of (a) an X-ray photoelectron emission process in an oxygen atom, and (b) the basic apparatus used in XPS. ....	40
<b>Figure 2.8.</b> Evanescent waveguide absorption spectrometer (EWAS) schematic set-up. ....	42
<b>Figure 2.9.</b> (a) Cross-section of a planar slab waveguide with the TIR light ray zigzagging along the waveguide. (b) The reflected light ray in TIR experiencing a lateral shift (Goos-Hänchen shift) at the interface. ....	43



<b>Figure 2.10.</b> The reflected light ray in TIR at the interface in (a) TE mode (s-polarization) and (b) TM mode (p-polarization). .....	44
<b>Figure 2.11.</b> Schematic diagram of an actual nulling ellipsometer.....	45
<b>Figure 2.12.</b> Immersion of a substrate in a solution of the surface-active material to form SAMs; along with a schematic of the resultant SAM.....	48
<b>Figure 2.13.</b> Structure of (a) a silane, (b) an OTS [ $\text{Cl}_3\text{Si}(\text{CH}_2)_{17}\text{CH}_3$ ] molecule, and (c) an MPTS [ $(\text{CH}_3\text{O})_3\text{Si}(\text{CH}_2)_3\text{SH}$ ] molecule.....	49
<b>Figure 2.14.</b> (a) Piranha solution ( $\text{H}_2\text{SO}_4:\text{H}_2\text{O}_2$ ) treatment to hydroxylate the silica surface. General scheme proposed for the silanization reaction of (b) OTS and (c) MPTS. ....	50
<b>Figure 2.15.</b> Fundamental steps involved in the CVD of organometallic precursor; along with the equations indicating the reaction of $\text{Me}_3\text{PAuMe}$ precursor to the surface. Me, (s), and (g) refer to methyl, solid molecule, and gaseous molecule, respectively.....	51
<b>Figure 2.16.</b> (a) Schematic of an OMCVD glass reactor chamber. (b) Proposed mechanism for gold OMCVD on a SH-terminated SAM; along with the equation indicating the reaction of $\text{Me}_3\text{PAuMe}$ precursor to the SH-terminated SAM. Me, (s), and (g) refer to methyl, solid molecule, and gaseous molecule, respectively. ....	52
<b>Figure 2.17.</b> TEM image of a 90-min OMCVD gold sample grown on an MPTS SAM. ....	53
<b>Figure 3.1.</b> XPS survey spectra of an OTS SAM on silica formed in 6 h assembly time (left) and of a cleaned Si substrate (right).....	66
<b>Figure 3.2.</b> AFM section analysis, AFM images, and SEM images of OTS SAMs on Si substrates with (a) 2 h, (b) 6 h, (c) 24 h, and (d) 48 h assembly time; baking temperature: 60 °C; AFM height scale bar: 0-30 nm; SEM scale bar: 200 nm. ....	69
<b>Figure 3.3.</b> XPS survey spectra of OTS SAMs formed in (a) 2 h, (b) 6 h, (c) 24 h, and (d) 48 h assembly time after an additional immersion in an MPTS solution and successive gold OMCVD process.....	73

**Figure 3.4.** SEM images of OMCVD gold nanoparticles grown on Si substrates (a) with and (b) without OTS SAM immersed in an MPTS solution, and cleaned Si substrates without MPTS self-assembly (c) with and (d) without OTS SAM.....74

**Figure 3.5.** Au(4f) XPS high-resolution spectra of OMCVD gold nanoparticles grown on Si substrates with (lower line) and without OTS SAM (upper peaks) immersed in an MPTS solution. ....76

**Figure 3.6.** RBS spectra of OMCVD gold nanoparticles grown on Si substrates with (left) and without OTS SAM (right) immersed in an MPTS solution .....77

**Figure 3.7.** UV-visible spectra of OMCVD gold nanoparticles grown on glass substrates with (lower line) and without OTS SAM (upper peaks) immersed in an MPTS solution.78

**Scheme 4.1.** Schematic of Au NP alignment process: (a) OTS deposition, (b) FIB, (c) MPTS refilling, and (d) Au OMCVD. ‘R’ is the rest group containing a carbon chain, and ‘X’s are the unknown groups including contaminations. *The scheme is not to scale.* Scales: the lengths of OTS and MPTS molecules, Au NP diameter, and Ga<sup>+</sup> ion beam size in FIB are typically in the order of 2.3 nm, 0.8 nm, 20 nm, and 10 nm, respectively. ....87

**Figure 4.1.** (a) Designed pattern and (b) SEM image of a FIB nano-lithographically patterned OTS SAM on a Si substrate with different sets of doses. Each set contains 10 lines with line separation = 800 nm, horizontal line length = 40 μm, and line width ≈ 80 nm for doses 0.5-10 nC/cm. ....91

**Figure 4.2.** AFM images of OTS FIB nano-lithographically patterned lines at a dose of (a) 0.5 nC/cm and (b) 15 nC/cm. ....92

**Figure 4.3.** ToF-SIMS images and line profiles selected perpendicularly to the line sets of (a) H<sup>-</sup>, (b) CH<sup>-</sup>, (c) SiO<sub>2</sub><sup>-</sup>, and (d) O<sup>-</sup> ions for FIB nano-lithographically patterned OTS layer with doses (left) 1-8 nC/cm and (right) 9-16 nC/cm.....93

**Figure 4.4.** Normalized ToF-SIMS ion intensity difference of H<sup>-</sup> (◆), O<sup>-</sup> (■), CH<sup>-</sup> (●), and SiO<sub>2</sub><sup>-</sup> (▲) versus Ga<sup>+</sup> ion dose of FIB nano-lithographically patterned OTS SAM on a Si substrate. The solid, dash, dot, and dash-dot lines represent Boltzmann fitting curves to

CH<sup>-</sup>, H<sup>-</sup>, O<sup>-</sup>, and SiO<sub>2</sub><sup>-</sup> ion intensity difference data with  $\chi^2_{\text{red}}$ s of  $5.7 \times 10^{-3}$ ,  $6.3 \times 10^{-3}$ ,  $2.7 \times 10^{-3}$ , and  $2.0 \times 10^{-3}$ , respectively.....95

**Figure 4.5.** SEM images of FIB nano-lithographically aligned OMCVD Au NPs with diameters of ~10 nm, after performing MPTS refilling; at a dose of (a) 2 nC/cm, (b) 4 nC/cm, and (c) 10 nC/cm. ....96

**Figure 4.6.** Average center-to-center spacing (along with the standard error as an error bar) between neighbouring NPs in the lines versus Ga<sup>+</sup> ion dose for the OMCVD grown Au NPs (a) after performing MPTS refilling with an exponential decay fit ( $\chi^2_{\text{red}} = 0.35$ ) and (b) without performing MPTS refilling with a horizontal linear fit ( $\chi^2_{\text{red}} = 1.01$ ).....97

**Figure 4.7.** SEM images of FIB nano-lithographically aligned OMCVD Au NPs with diameters of ~20 nm, without performing MPTS refilling; at a dose of (a) 2 nC/cm, (b) 4 nC/cm, and (c) 10 nC/cm. ....98

**Scheme 5.1.** Schematic of the Au NP density control process: (a) OTS deposition, (b) ion bombardment/irradiation on one half of the sample while the other half is protected by a silicon mask, (c) MPTS re-filling, and (d) OMCVD for Au NP deposition. ‘R’ is the rest group containing a carbon chain, and ‘X’s are the unknown groups including contaminations. *The scheme is not to scale.* Scales: the lengths of OTS and MPTS molecules, Au NP diameter, and Cu<sup>-</sup> ion beam size are typically in the order of 2.3 nm, 0.8 nm, 30 nm, and 1.13 cm<sup>2</sup>, respectively. Note that the Au NP size difference between Scheme 4.1 and 5.1 is due to the use of two differently prepared Au precursors for the OMCVD processes. ....106

**Figure 5.1.** Static contact angle versus ion dose for unirradiated (■) and irradiated (●) sides, along with error bars presenting the standard deviations of 3 measurements on each side. The dashed and solid lines are a horizontal linear fit ( $\chi^2_{\text{red}} = 0.25$ ) and an exponential decay fit ( $\chi^2_{\text{red}} = 0.61$ ) for the unirradiated and the irradiated side, respectively. The ‘dose zero’ data point represents the average of the unirradiated side contact angles shown by ■. ....112

**Figure 5.2.** XPS survey spectra of the sample (a) irradiated at  $2 \times 10^{15}$  ions/cm<sup>2</sup> and (b) its unirradiated side. C(1s):O(1s) [■], C(1s):Si(2p) [●], and Si(2p):O(1s) [▲] ratios versus ion dose for (c) irradiated and (d) unirradiated side, along with error bars presenting the standard deviations of 3 XPS measurements on each side. The solid, dashed, and dotted lines are fits for C(1s):O(1s), C(1s):Si(2p), and Si(2p):O(1s) ratios with  $\chi^2_{\text{red}}$  of 2.68, 6.34, and 1.04 for (c) and 0.53, 2.04, and 1.12 for (d), respectively..... 113

**Figure 5.3.** Carbon high-resolution XPS spectra of the sample (a) irradiated at  $2 \times 10^{15}$  ions/cm<sup>2</sup> and (b) its reference side. Graph (c) is C-C/C-Si ratio versus ion dose; along with error bars presenting the standard deviations of 3 measurements on each side, and an exponential decay fit ( $\chi^2_{\text{red}} = 4.9 \times 10^{-2}$ )..... 115

**Figure 5.4.** SEM images of OMCVD grown Au NPs after performing MPTS refilling for the sample (a) irradiated at  $2 \times 10^{15}$  ions/cm<sup>2</sup>, (b) the interface, and (c) its reference side. The particles in images (b)right and (c) are considered as ‘undesired’ Au NPs..... 116

**Figure 5.5.** Histograms of (a, b) lateral size (diameter) distribution and (c, d) center-to-center NND distribution of OMCVD grown Au NPs for the sample (left) irradiated at  $2 \times 10^{15}$  ions/cm<sup>2</sup> and (right) its reference side; along with (a, b) Gaussian fits and (c, d) Poisson fits to the bin centres of the histograms with  $\chi^2_{\text{redS}}$  of  $4.2 \times 10^3$ ,  $1.3 \times 10^1$ ,  $2.4 \times 10^{-4}$ , and  $4.5 \times 10^{-4}$ , respectively. .... 118

**Figure 5.6.** RBS spectra of the sample (a) irradiated at  $2 \times 10^{15}$  ions/cm<sup>2</sup> and (b) its reference side after performing MPTS refilling and gold OMCVD, with logarithmic y-axes to present the Au peaks more recognizably. Graph (c) represents counts and corresponding number of Au atoms/cm<sup>2</sup> versus ion dose; along with error bars presenting the standard deviations of 3 RBS measurements on each sample, and an exponential growth fit ( $\chi^2_{\text{red}} = 11.2$ )..... 122

**Figure 5.7.** High-resolution XPS peaks for Au(4f) versus ion dose and an exponential growth ( $\chi^2_{\text{red}} = 21.9$ ) fitted to Au(4f<sub>7/2</sub>) peaks. .... 123

**Figure 5.8.** SEM images of OMCVD grown Au NPs without performing MPTS refilling for the sample irradiated at (b)  $1.0 \times 10^{14}$ , (c)  $2.5 \times 10^{14}$ , (d)  $5.0 \times 10^{14}$ , (e)  $7.5 \times 10^{14}$ , and (f)

1.0×10<sup>15</sup> ions/cm<sup>2</sup>; along with the sample (g) irradiated at 2.0×10<sup>15</sup> ions/cm<sup>2</sup>, (a) its reference side, and (h) the interface. .... 124

**Figure 5.9.** RBS spectra of the sample (a) irradiated at 2×10<sup>15</sup> ions/cm<sup>2</sup> and (b) its reference side after performing gold OMCVD without MPTS refilling. The graph (c) represents the counts and the corresponding number of Au atoms/cm<sup>2</sup> versus ion dose; along with error bars presenting the standard deviations of 3 RBS measurements on each sample. .... 125

**Figure 6.1.** Pattern for FIB nanolithography on each sample including 16 different doses: ‘L’ (lower doses) 0.5, 1, 2, 3, 4, 5, 5.5, 6 nC/cm and ‘H’ (higher doses) 6.5, 7, 7.5, 8, 8.5, 9, 10, 11 nC/cm (top to bottom); along with the SEM image of OMCVD grown Au NPs on refilled lines with 80 v/v% of MPTS and FIB irradiated at 3 nC/cm. Patterns ‘L’ and ‘H’ were not horizontally aligned to easily locate the series of lines corresponding to each dose by SEM. .... 136

**Figure 6.2.** SEM images of FIB nanolithography aligned Au NPs at a dose of 0.5 nC/cm refilled with (a) 0 v/v%, (b) 20 v/v%, (c) 40 v/v%, (d) 60 v/v%, (e) 80 v/v%, (f) 100 v/v% of MPTS, and (g) without any refilling..... 137

**Figure 6.3.** SEM images of FIB nanolithography aligned Au NPs at a dose of 1 nC/cm refilled with (a) 0 v/v%, (b) 20 v/v%, (c) 40 v/v%, (d) 60 v/v%, (e) 80 v/v%, (f) 100 v/v% of MPTS, and (g) without any refilling..... 137

**Figure 6.4.** Average center-to-center spacing between aligned Au NPs at doses of 0.5, 1.0, 4.0, and 11 nC/cm versus the v<sup>o</sup>/v<sup>o</sup> ratio of MPTS/OTS binary mixture. The error bars represent the standard errors of the mean of the NNDs. .... 138

**Figure 7.1.** SEM images (left), UV-Vis absorption data points and their smoothed spectra (middle), and their first derivatives (right) at parallel (||) and perpendicular (⊥) polarization directions to aligned OMCVD Au NPs grown on FIB irradiated OTS SAMs at a dose of (a) 0.05 nC/cm refilled with MPTS, (b) 0.05 nC/cm without refilling, and (c) 0.5 nC/cm without refilling. .... 148

**Figure 7.2.** UV-Vis absorption data points, their smoothed spectra, and their first derivatives for randomly grown Au NPs with 30-min OMCVD at two 90° rotated polarization directions.....149

**Figure 7.3.** UV-Vis absorption data points, their smoothed spectra, and their first derivatives for randomly grown Au NPs with 15-min OMCVD at two 90° rotated polarization directions.....150

## List of Tables

<b>Table 3.1.</b> XPS binding energy peak ratios, contact angle measurements, and ellipsometric thicknesses for OTS SAMs on Si substrates; with different assembly times and baking temperatures .....	67
<b>Table 3.2.</b> AFM and SEM analyses for OTS SAMs on Si substrates with different assembly times, baked at 60 °C .....	71
<b>Table 5.1.</b> SEM image analyses of OMCVD grown Au NP surfaces irradiated with different doses .....	119

# Chapter 1

## Introduction

### 1.1. Background and Objectives

The new area of science termed ‘Nanoscience’ or more popularly ‘Nanotechnology’ refers to an internationally well-recognized research field to manufacture and control the assembly of nanoscale objects for building functional devices for technological or even essential daily applications. ‘Nanoparticles (NPs)’ are defined by their sizes within diameters of 1-100 nm.<sup>[1]</sup> Metal NPs have attracted special interests due to their easy chemical synthesis and modification.<sup>[2]</sup> In contrast to noble metals in bulk, their NPs show interesting photophysical, photochemical and photocatalytic effects.<sup>[3]</sup> In addition, typically gold (Au) and silver (Ag) NPs are well-known for an optical absorption feature called ‘localized surface plasmon resonance (LSPR)’.<sup>[4]</sup> LSPR enables noble metal NPs to be used in a wide range of applications, such as biodetection at the single molecule level and high-resolution optical imaging below the diffraction limit, which are based on an enhanced field outside the NP when the particle is illuminated at its resonance

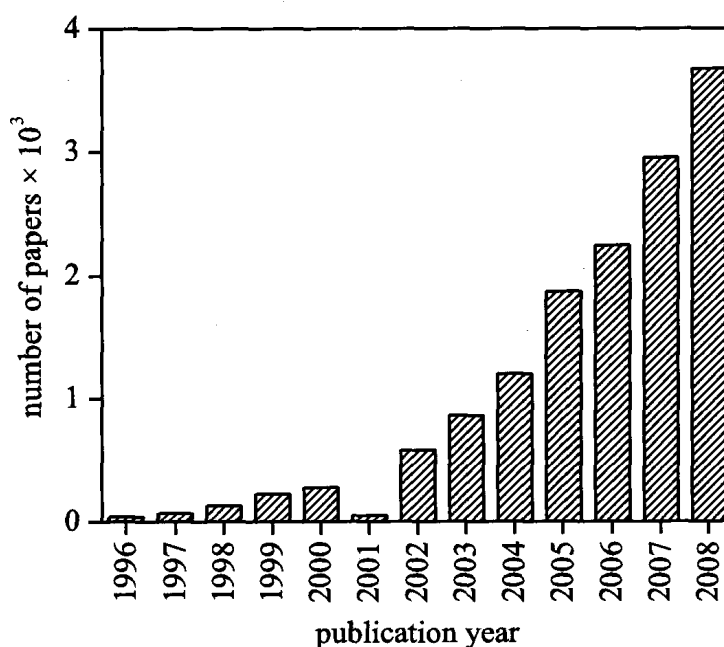


frequency.<sup>[5]</sup> LSPR and enhanced fields in the vicinity of the NPs will be described in more detail later in this chapter.

Although Au is one of the oldest themes in scientific investigations, Au NPs have been the focus of intensive research in recent years.<sup>[6]</sup> Figure 1.1 shows an increasing number of publications in the field of Au NPs. The sensing applications (e.g. genomics, proteomics, and biomedical and bioanalytical sensors) of Au NPs have particularly drawn tremendous attention from academics and industry.<sup>[7]</sup> The LSPR of Au NPs appears typically in the visible or near-infrared spectral range.<sup>[8]</sup> The spectral location and width of the LSPR depend on size, shape, average spacing, and surrounding material.<sup>[8-12]</sup> In most of current Au NP LSPR sensors, spherical Au NPs, in solution or on surfaces, are implemented to transmission UV-Vis spectroscopy to depict the LSPR or 'absorption' spectra.<sup>[12-18]</sup> It is of great importance to observe a 'pronounced shift' in the LSPR upon binding of a material onto the Au NPs. However, to achieve such a pronounced LSPR shift - when only a minute amount of sample material is available, or in a screening approach with many different recognition agents - the volume has to be minimized and the accessibility of the analyte to the Au NPs has to be enhanced. Therefore, two-dimensional approaches with immobilized Au NPs on a surface are envisaged.

Thiol templated organo-metallic chemical vapour deposition (OMCVD) is a method for preparing Au NPs that are covalently attached to the surface.<sup>[19]</sup> In this process, where particle growth occurs directly at a functionalized surface, a volatile organo-metallic precursor is used.<sup>[20]</sup> Thiol templated OMCVD offers several advantages, aside from the possibility of an area selective deposition.<sup>[21]</sup> Here, nucleation and growth only occur on so-called growth areas (thiol groups).<sup>[22]</sup> It is also an economical, environmentally friendly and a soft method as the deposition process takes place under low pressure and relatively low temperature, and avoids solution or airborne nanoparticles. The particle size is controlled by the deposition time factor. The particles are immobilized on surfaces and fixed in their morphology. In addition, the OMCVD Au NPs are free from surface and stabilization agents, and flexible for further functionalization because they are not capped for colloidal stabilization.<sup>[23]</sup> In sensing applications, and generally because of

health and environmental issues with nanomaterials,<sup>[24]</sup> particularly where bindings to Au NPs have to be done from a solution,<sup>[25]</sup> chemisorbed Au NPs to the surface (covalent Au-S bond) are preferred rather than particles only loosely physisorbed to a surface.



**Figure 1.1.** Number of publication entries in the ISI Web of Knowledge<sup>SM</sup> for the topic 'gold nanoparticles'.

The distribution of the OMCVD grown Au NPs immobilized on surfaces is random (e.g. see Figure 3.4).<sup>[25, 26]</sup> It is interesting to note that in some systems of deposited particles (e.g. Sn clusters on Si substrates) and under certain conditions (e.g. Ostwald ripening), the spatial distribution of the particles is neither random nor fully ordered.<sup>[27, 28]</sup> However, the Ostwald ripening has not been reported for the OMCVD Au NPs so far, and their distribution is assumed to be random. In the sensing systems based on Au NPs in solutions, the LSPR peak can be fairly broad.<sup>[29]</sup> This might be the case for randomly OMCVD grown Au NPs as well, due to a large number of touching, clustering, or overlapping Au NPs. One of the key factors to optimize the spectral location and width of the LSPR peak is to control the distribution or more specifically 'interparticle distance' or 'average spacing' of Au NPs.<sup>[30]</sup> As a result, a sensor fabricated with Au NPs with a