Electronic Gaming and Social Adjustment in Early School-Aged Children: A Two-Wave Cross-Lagged Design

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Master of Philosophy at the Department of Psychology

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Abstract

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The objective of this study was to investigate the associations and directionality between electronic gaming frequency and social adjustment in a cohort of early school-aged Norwegian children. Despite substantial interest in the topic, very few studies have investigated longitudinal associations. Most of the available studies have focused on children who are eight years old or older. There is also a lack of studies conducted outside of American culture. The present study used existing data from the research project SKOLEKLAR, conducted by the Center for Learning Environment at the University of Stavanger in 2012/2013. A total of 243 children participated in the study. Data was collected at two time points: first, when the children were in the last year of kindergarten (T1), and the second time the following year when they were in first grade of elementary school (T2). A cross-lagged structural equation modeling was used to analyze data. Social adjustment was measured using prosocial behavior and peer problems subscales from the Strength and Difficulties Questionnaire teacher rated version, as latent variables. Electronic gaming was measured as total amount of hours spent on gaming on various platforms, reported by the parents. Gender, sex, and socio-economic status were included as covariates. Cross-lagged analyses showed that a higher electronic gaming frequency at T1 was significantly related to lower prosocial behavior at T2. No significant associations were found for gaming and peer relationship problems. The mixed results can be attributed to low variability, construct validity of the peer relationship problem scale, and potential selective or compensative processes. Furthermore, prosocial behavior at T1 did not predict any change in gaming at T2. There was a significant difference between the two directions of influence. Thus, the results indicate one-directional influence from electronic gaming frequency to later change in social adjustment.
Acknowledgements

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1 Introduction

Video gaming entered the mainstream culture in the early 80s and quickly became a popular activity among children and young adults. With the massive increase in computer use and vast proliferation of handheld devices over the last two decades, computer games has now become an integral part of young children and adolescents everyday life. A survey from The NPD Group, Inc. (2011) revealed that 91% of children between 2 – 17 years old played computer games. A national survey shows that 80% of Norwegian children from 9 – 15 years old play electronic games (Vaage, 2017). Children from 9 – 12 years old play electronic games for 58 minutes a day on average, while 13 – 15-year-old children play for 69 minutes per day on average. To our knowledge, there are no survey data on preschool children in Norway with regards to their habits in this area.

Despite the all-pervasive nature of the phenomenon, the knowledge on the effects of computer games on general psychosocial development is still limited. The general public, and especially parents, are eager to know if electronic gaming is good or bad for children. Research findings so far have been too inconsistent to reach a firm conclusion (Anderson et al., 2010; Ferguson & Kilburn, 2009; Greitemeyer & Mügge, 2014). Video games seem to be associated with both positive and negative aspects of psychosocial adjustment (Ferguson, 2013). Even though the subject matter has generated quite a substantial body of research, knowledge gaps still remain. First and foremost, the vast majority of research has focused on older children and adolescents (Kovess-Masfety et al., 2016), yet children as young as five years old or younger have access to electronic games (NPD Group, 2011). Additionally, the gaming frequency among toddlers and preschool children has increased significantly (Vaage, 2017). Second, as is the case with most of psychological research, almost all of the studies have been conducted in the United States (Parkes, Sweeting, Wight, & Henderson, 2013). Last, very few research studies are of longitudinal character (Lobel, Engels, Stone, Burk, & Granic, 2017). Due to the limitations of cross-sectional studies, research questions on whether electronic games predicts a change in social adjustment or vice versa, whether social adjustment among younger school children can predict change in hours spent on electronic games, has largely remained unexplored (Greitemeyer & Mügge, 2014). The rationale for examining whether preconditions in psychological characteristics can influence the amount of electronic gaming, is based on theoretical inferences and empirical findings indicating that
people with poor social skills tends to turn to the digital world and electronic gaming (e.g. Durkin, 2010; Mazurek, Shattuck, Wagner, & Cooper, 2012).

1.1 Objectives of The Present Study
The aim is to examine if there is an association between electronic games and social adjustment. We will attempt to narrow the gaps in the current research in these areas by studying younger children than the existing research, by employing a longitudinal cross-lagged design, and by using a Norwegian sample. The research questions are stated as follows: (1) Does electronic game play among children in kindergarten predict change in social adjustment in first grade of school? (2) Does social adjustment among children in kindergarten predict change in hours spent on electronic games in first grade of school? and (3) Are the two directions of influence equal, or is one stronger than the other? If an association in the two directions is approximately equal, a reciprocal effect is found, if one direction is stronger than the other, the association is mainly one-directional.

1.2 Definition of Electronic Gaming and Social Adjustment

1.2.1 Electronic gaming.
Electronic games are often defined as devices in digital visual medium, which are indented to act as an object of entertainment (Tavinor, 2008). Its primary purpose is to provide entertainment through interactive fiction and/or rule-bound gameplay. The term “electronic games” therefore encompasses all kinds of “video games”, which was the most common term in the beginning when they were mainly played on consoles or video devices via the TV screen. The term “computer games” is more commonly used nowadays and refers to games played on personal computers of some kind, although the two expressions have also been used interchangeably. Throughout this thesis electronic games will be discussed as interactive fiction and rule-bound gameplay on all platforms, including computer (e.g. PC games), internet (e.g. games and task from web-pages), consoles (e.g. Nintendo Wii and DS, PlayStation) and smartphone/tablet.

In previous research studies, some have applied a narrow focus, treating internet games as a separate subcategory (e.g. Lobel et al., 2017), while others have chosen to expand further by examining all sedentary activities under one, including for example TV watching (e.g. Parkes et al., 2013). A few studies uses a summed gaming frequency measure (e.g. Parkes et al., 2013).
Kovess-Masfety et al., 2016), while quite many categorize according to content, examining for example “violent games”, “competitive games”, or “social games” (e.g. Gentile et al., 2009; Lobel et al., 2017).

Electronic games can vary in an infinite number of ways, but the common denominator is that the games are designed to stimulate and continuously hold the attention of the player. This is achieved either by using shifting visuals and sounds, and/or by constantly challenging the player to perform on increasingly advanced tasks. This core feature of electronic games secures its extreme popularity, while simultaneously facilitating for addictive gaming. Yee (2006) used a factor analytic approach and identified three different groups who spend more time playing electronic games compared to others. The first group is called achiever gamers who seek to play more electronic games because of the mastery and competence. The desire to challenge and progress rapidly, as well as having an interest in rules and systems are what characterize achiever gamers. The second group is named social gamers. They want to interact with others, form meaningful peer relationships, and are driven by a desire to be a part of a bigger team. The final group is called immersion gamers. These individuals immerse themselves in electronic gaming or a virtual reality because they wish to escape real life problems. The immersion gamers are often what people will call “problematic” or “addictive” gamers (Skoric, Teo, & Neo, 2009). Numerous studies have indicated that addictive electronic game play was positively associated with depression and anxiety (e.g. Kuss & Griffiths, 2012; Maras et al., 2015). However, there is still no standardized definition of the concept “gaming addiction”. It is also unclear whether electronic gaming is the cause of depression or if depression precedes the development of pathological gaming (Liang, Zhou, Yuan, Shao, & Bian, 2016; Skoric et al., 2009).

1.2.2 Social adjustment.

The research literature shows great variety in terminology and conceptual use of “social adjustment”. The definition has also varied across studies. Terms like “social adaptation”, “social skills”, “social functioning”, as well as social adjustment, can generally be defined as the degree to which children engage in adaptive, appropriate, competent social behavior, and the extent to which they inhibit aversive, inappropriate, incompetent behavior, including the degree to which they get along with their peers (Cavell, 1990; Crick & Dodge, 1994). There is, however, no consensus on how the concept of social adjustment is operationalized in scientific research. “Prosocial skills”, “antisocial” or “aggressive behavior”, “emotional and
“social regulation”, “behavioral problems”, “peer relationship”, and “peer problems” are all examples of terms that have been used as concepts of social adjustment in previous studies. The present study will include prosocial behavior and peer relationship problems as latent variables.

**Prosocial behavior.**
Prosocial behavior is generally defined as actions undertaken with the intention of improving the circumstances of other individuals where the motivation of the helper is characterized by perspective taking and empathy (Bierhoff, 2009; Eisenberg, Fabes, & Spinrad, 2006). As children develop, the ability to empathize and sympathize with others emerges. Knowledge of emotions among preschool children has been positively related to prosocial behavior (Denham & Couchoud, 1991). Traditional forms of play, which include sharing and building of relational skills, have been shown to provide a positive environment for children’s social development (Erikson, 1977; Piaget, 1962; Vygotsky, 1978).

Based on a meta-analysis that examined age-related change in prosocial behavior, prosocial skills generally increased over the preschool and school years (Eisenberg & Fabes, 1998). The data supports the notion that as children grow older, prosocial behavior is more likely to occur. Despite the age-changes in children’s prosocial behavior, there appears to be a noticeable stability in the children’s respective level of prosocial skills and responses (Eisenberg et al., 2006). Côté, Tremblay, Nagin, Zoccolillo, & Vitaro (2002) support the notion of age-changes in children’s prosocial behavior by examining the continuity of trajectories for helpfulness across early elementary school. They found that children, who entered kindergarten with a specific level of prosocial skills compared to other children, will also, typically, finish the primary school at a similar degree. The development of prosocial behavior can therefore be said to contain developmental continuity (Eisenberg & Fabes, 1998; Eisenberg, Spinrad, & Knafo-Noam, 2015). A longitudinal study with a total of 245 children, found that girls with a relative lack of prosocial behavior at the start of the school year were predicted to become less accepted and more rejected by peers during the course of the year compared to girls with higher level of prosocial skills (Crick, 1996).

**Peer relationship problems.**
Peer relationship problems are often understood as poor or poorer skills at managing joint attention, regulating emotions towards peers, imitating another child’s actions, inhibiting impulses, and understanding cause-and-effect relationships (Rubin et al., 2015). They are
essential aspects of social adjustment, but children’s behavior and relations with their peers also play a major role in their general development (Eisenberg et al., 2015). Having a good peer relationship can promote or support positive adjustment towards others (Berndt & Keefe, 1995). Similarly to the development of prosocial behavior, as children grow older, they become increasingly competent and interactive at maintaining and initiating social changes (Rubin et al., 2015). At the same time, children become more adept at establishing shared meanings with their peers (Goldstein, Kaczmarken, & English, 2002). Children therefore become more and more competent at resolving relational dilemmas and achieving their social goals (Rubin & Rose-Krasnor, 1992). Simultaneously, they also become better at engaging in rule-bound, competitive games with age.

Woodward & Fergusson (2000) documented correlation between children’s peer relationship and their school-related activities and achievement. They examined relations between the extent of children’s peer relationship problems at age nine and their later risks of educational underachievement and unemployment by the age of eighteen. Participants were members of a birth cohort that has been extensively studied as part of Christchurch Health and Development Study (CHDS). Results showed that children with high rates of early peer problems were at an increased risk of underachievement compared with children with low rates of early peer problems. Rubin et al. (2015) reported that children who enter elementary school together with a mutual friend report a higher level of school and academic satisfaction compared to children who begin the school year without a friend. Furthermore, ratings of sociability increase increases during the transition into elementary school for children who have high-quality and stable friendships (Berndt, Hawkins, & Jiao, 1999). In yet another study, children without mutual friends, regardless of the reasons, report higher rates of loneliness compared to children with mutual friendships (Parker & Seal, 1996). Also, children who experience difficulties making friends and getting along have an increased risk of various negative psychosocial outcomes, such as mental health problems (Newcomb, Bukowski, & Pattee, 1993) and conduct problems (Hodges, Boivin, Vitaro, & Bukowski, 1999). Children with peer relationship problems during early childhood have been shown to have a greater risk of developing learning difficulties (Wentzel & Asher, 1995) and early school leave (DeRosier, Kupersmidt, & Patterson, 1994).
1.3 Empirical Findings of Electronic Games and Social Adjustment

According to Greitemeyer & Mügge (2014) nine meta-analyses have been published about the effects of electronic games. Five meta-analyses have so far been published demonstrating the negative effects of electronic games on school children and youths (Anderson, 2004; Anderson & Bushman, 2001; Anderson et al., 2004; Anderson et al., 2010; Sherry, 2001). Three meta-analyses have questioned this link (Ferguson 2007a, 2007b; Ferguson & Kilburn, 2009). The latest meta-analysis demonstrated both positive and negative effects of electronic games (Greitemeyer & Mügge, 2014). Content of electronic games was captured in all of the meta-analyses, with violent content and aggression as the main target. We found no meta-analyses focusing exclusively on general electronic game usage and social adjustment. The five meta-analyses demonstrating negative effects of electronic games support the hypothesis that exposure to violent electronic games is positively associated with heightened levels of aggression, and negatively associated with prosocial behavior.

In one interesting study, children between 10 – 15 years were divided into four groups according to how much they played electronic games; non-players, low level players who played less than 1 hour per day, moderate players who played between 1 and 3 hours per day, and high level players who played more than 3 hours per day (Przybylski, 2014). The results of this study indicates that a low level of engagement in electronic gaming is associated with higher life satisfaction and prosocial behavior, and lower levels of externalizing and internalizing problems, whereas the opposite was found for high levels of play. Moderate electronic game play levels did not have any effect compared to non-players. These results imply that there is a possibility that previous research have reached false negative conclusions and ignored potential non-linear effects because they have not differentiated between levels of electronic gaming engagement.

1.3.1 Electronic games and prosocial behavior.

The majority of existing electronic games studies concern effects on prosocial behavior (Greitemeyer & Mügge, 2014). We found no studies specifically investigating the association between electronic games and peer relationship problems. The three meta-analyses that questioned the existence of the link between electronic games and negative outcomes, argued that, once corrected for publication bias, there was little evidence that violent electronic
games would increase aggression and violence-related behavior and decrease prosocial outcomes (Ferguson 2007a, 2007b; Ferguson & Kilburn, 2009).

Proponents of electronic games argue that electronic games can be viewed as a meaningful form of modern play. Just as traditional play, electronic games can provide a positive context for children’s social development (Adachi & Willoughby, 2017). One of the potential reasons is that although the play has moved from a physical playground to a digital one, the concept of playing remains the same. Compared to electronic games two decades ago, contemporary games have become more socially interactive and prosocial in nature (Ewoldsen et al., 2012). Many electronic games are now designed for multiple players where they are encouraged to cooperate, making cooperation a fundamental feature. These games do indeed provide a positive context for social development as cooperative electronic games seems to promote prosocial behavior and strengthen bonds with peers (Granic, Lobel, & Engels, 2014; Greitemeyer & Mügge, 2014).

Experimental studies have also demonstrated that children who played electronic games with cooperative content were more likely to help others (e.g. Gentile et al., 2009) and were positively associated with empathy (e.g. Prot et al., 2014). Gee (2003) suggests that playing electronic games can be applied as a useful teaching device as these games can enhance prosocial behavior and thereby provide non-violent solutions to social conflicts. The potential reason for this outcome is that helping other game characters during the gameplay may prime cognitions related to prosociality. However, the most recent meta-analysis conducted by Greitemeyer & Mügge (2014) demonstrates that content of electronic games is essential for the outcomes. Whereas exposure to violent electronic games increases aggression, prosocial electronic games decreases aggression and increases prosocial behavior. Granic et al. (2014) have also pointed out that whether electronic games are interactive fiction or rule-bound gameplay can be a crucial aspect when determining the potential association.

In recent years, research on the impact of electronic games among preschool and younger school children has begun to emerge. Lobel and his colleagues conducted a cross-lagged study in 2017 with children from seven years of age. 194 children participated and were measured twice with one year apart. The study reported children’s gaming frequency, in addition to their tendencies to play violent electronic games and/or those with cooperatively and competitively content. They found gaming frequency was related to increases in internalizing, but not externalizing and peer relationship problems. On the other hand, a cross-sectional study including more than 3000 European school children aged 6 – 11 across
six European countries found that high gaming frequency were actually associated with a significantly lower prevalence of peer relationship problems and mental health difficulties, and high intellectual functioning and academic achievement (Kovess-Masfety et al., 2016). The study differed from others by including more covariates: age, gender, number of children, mothers’ age, marital status, education, employment status, and region.

1.4 Applicable Background Theories

1.4.1 Social learning theory.
According to Albert Bandura (1965, 2004), people learn by observing the behavior of others, after which this behavior is modeled and added with the understanding that it can be reproduced and thereby affect events significant to the individual’s life. The importance of acquiring behavior through modeling thus constitutes a prerequisite for the child’s development. In this way young school children who are exposed to, for example, prosocial electronic gaming will be more likely to model the same behavior during interaction with others as a results of the active observation and imitation of the characters on the screen (Sherry, 2001; Silvern & Williamson, 1987). Data from 98 independent studies from a meta-analytic review by Greitemeyer & Mügge (2014) revealed that exposure to electronic games with prosocial content can affect social outcomes such as prosocial behavior in early and late childhood.

However, in order to take advantage of model learning, the child must be aware of the behavior performed, be able to retain the information in memory, reproduce the observed behavior, and be motivated to perform the behavior (Bandura, 1977). A negative correlation between electronic gaming and social adjustment can therefore be explained by social learning theory to the extent that time spent on electronic games may reduce social interactions with positive role models in real life, i.e. electronic gaming deprives the child of important opportunities to observe and thereby learn and model social behavior.

1.4.2 Theory of mind: Affective perspective-taking.
Theory of Mind (ToM) is defined as a multidimensional social-cognitive ability that enables an understanding of other peoples’ mental states (Birch et al., 2017; Wellman, 2014). This ability develops early and becomes particularly active around four to six years of age (Lagattuta et al., 2015). In the article by Eisenberg, VanSchyndel, & Spinrad, (2016) it is
argued that social-cognitive processes, such as affective perspective-taking (APT), are a necessary requirement for prosocial behavior, but that this, in itself, does not mean that individuals act prosocially. Affective perspective-taking can be defined as the ability to perceive, understand, and derive conclusions about other people’s emotional states (Eisenberg & Fabes, 1998).

Based on the dimensional prosocial understanding of motivation, it is the experience of empathy and sympathy in particular that underlies various prosocially oriented behavior. Because sympathy can directly emanate from perspective-taking, APT could facilitate prosocial motivation through its impact on and support for this ability (Oswald, 2010; Vaish, Carpenter, & Tomasello, 2009). In this way, APT could influence prosocial behavior based on the impact of this ability on the child’s prosocial development, which facilitates a functionally new and more advanced form of prosocial motivation. Children’s motivation for acting prosocially depends, among other factors, on whether they are oriented towards their own needs or the needs of others (Eisenberg-Berg & Hand, 1979; Eisenberg et al., 2016). ToM is a prerequisite for the child’s development to move from a selfish understanding towards a greater degree of empathy and other-oriented prosocial behavior (Eisenberg et al., 2016; Vaish et al., 2009).

Similarly to social learning theory, APT might explain a negative correlation between electronic gaming and prosocial behavior under the assumption that children, who play more electronic games, have less direct interaction with peers and adults. One example is Uhls et al.’s field experiment (2014) which examined whether increased opportunities for face-to-face interaction, by eliminating all screen use for five days, improved non-verbal emotion-cue recognitions in preteens. The group spent five nights at an overnight nature camp with no access to any electronic device. Uhls and her colleagues found that the recognition of non-verbal emotion-cues improved significantly compared to the control group. This indicates that children who are occupied with electronic devices will get less opportunity to develop an understanding of the emotional mindset of others.

1.4.3 Self-determination theory.

Self-determination theory (SDT) explains that there are three basic psychological needs: competence, autonomy, and relatedness (Deci & Ryan, 2011). According to SDT, activities that satisfy one of these three fundamental human needs will foster great motivation. Most children have the need for social connectedness and the feeling of autonomy, and self-
determined social interaction has always been an integral part of electronic games (Przybylski, Rigby, & Ryan, 2010). In that way, children who are well-adjusted socially will most likely seek to play electronic games, because they have the opportunity to maintain peer relationships and develop social bonds by cooperating with others while playing electronic games (Ryan, Rigby, & Przybylski, 2006). This group of players is what Yee (2006) will refer to as social players. Additionally, children who have poor or poorer social adjustment skills can also pursue playing more electronic games, as it might be easier to handle social rule-bound gameplay than real-life interactions (Olson, 2010). This latter group is categorized as immersion gamers (Yee, 2006). Because of the need to satisfy social relatedness and autonomy, it represents an important element in explaining why some children with either high or low social adjustment skills seek towards the activity of electronic gaming.

Electronic games also fulfill the need for feeling competent for children and adolescents with various developmental disorders, such as Autism Spectrum Disorders (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and Specific Language Impairment (SLI) (Durkin, 2010; Mazurek & Engelhardt, 2013). Children and adolescents with ASD are motivated by the skill challenges of electronic games, because they master how to do something through games that, typically, they cannot do in normal life (Winter-Messiers, 2007). This group of individuals fits Yee’s (2006) definition of “achiever gamers” as people who seek to play electronic games because of the mastery and advancement opportunity in electronic games. SDT can therefore offer a possible theoretical starting point for research question two in the present study, if there is a significant association between pre-existing social adjustment levels and an increase or decrease in amount of electronic gaming at a later time.

1.4.4 The transactional model of development.

The transactional development model builds on the assumption that biological and environmental causation factors are part of complex continuous interactions that lead to mutual changes over time (Sameroff, 2009; Sameroff & Chandler, 1975). Transactional development can be understood as both a transformation and a development in which both the individual and the environment actively transform both themselves and each other, and that there is bi-directional, mutual plasticity. The child’s behavior affects the environment it is in, and the environment responds to the child’s behavior. In this way, the child shapes and is shaped by the environment, which, among other factors, means that the child actively
contributes to the creation of its own environment (Davidov, Knafo-Noam, Serbin, & Moss, 2015). Put in another way, Griffiths & Hunt (1995) explain that a child plays electronic games to impress their friends because they seek peer approval, and, by repeated electronic game play, the child will be more likely to model the same behavior from the electronic game content (Sherry, 2001). If the peers around encourage the behavior, the child may likely to continue the behavior and then shape the peer environment even further.

Applied to our research subject, the transactional development model can offer an explanation on several of the possible outcomes. In the case of no significant findings between prior electronic gaming frequency and subsequent social adjustment, no change in social adjustment may be understood as the result of an adaptive transactional process where children with impaired social skills manage to compensate for their weakened skills, by, for example, symmetrically bond with other children who play the same types of electronic games. In the case of a significant association between electronic gaming and social adjustment in both directions, a reciprocal effect would be the perfect demonstration of the transactional model by opening up for the possibility of a self-reinforcing mechanism between the two variables.
2 Methods

2.1 Procedure

All data in the present study comes from a research project called SKOLEKLAR (“Ready for School”), conducted in 2012/2013 by the Center for Learning Environment at the University of Stavanger in Norway. SKOLEKLAR’s main objective was to examine factors related to learning and school achievement in children during the transitional years between kindergarten and school, with special focus on self-regulation and social skills. Data on the children’s adjustment, development, mental health, school functioning, and social relations were collected using a range of different methods, from parent and teacher scored questionnaires, to direct testing of the children and observations. The same procedure of data gathering was done at two time points with one year in between measurements. For more detailed information on the procedure, see Størksen, Ellingsen, Vanless and McClelland (2015). In the present study we will focus on survey data of electronic gaming and from the Strengths and Difficulties Questionnaire (SDQ).

2.2 Participants

All children in their last year of kindergarten from the municipality of Klepp in Norway were invited to participate in the study. Participants received written information about the study together with a consent form, which was required signed for participation in the project. Seven parents with poor levels of language knowledge in Norwegian and English were excluded, due to requirements from NSD in accordance with the guidelines on informed consent. To compensate for this, eleven families with minority background from two other kindergartens in a municipality nearby, Sandnes, were invited to participate, seven of whom accepted.

In total 243 (84.70%) children and their families participated out of the 287 families who were initially invited. Of them, 119 children were girls (49%) and 124 boys (51%). Mean ages of the children at time one were 5.8 years (SD = .29). Thirty-one children (12.80%) came from families with minority background, of whom 13 had both parents from a foreign country, and 18 had one of their parents from another country. Among the 243 children in the study, 24 (9.90%) had received some form of specialized assistance or special education in school, in most cases due to language and/or general behavior problems. Of the
243 participants, we excluded 14 due to non-response missing data and outlier labeling (see results chapter). Table 1 (see below) therefore only includes 229 participants.

In the sample study, mothers had, on average, a higher education level (score = 3.28) than fathers (score = 2.83). The gender difference was further pronounced when it came to the highest level of education. In total, 48.33% of the mothers reported having three years of college/university education or more, compared to 28.69% of the fathers. Education level was measured using the following standard: 1 = junior high school, 2 = senior high school, 3 = 1 – 2 years of college or university education, 4 = 3 years of college or university education, 5 = more than 3 years of college or university education. Only 9 (4.11%) families reported having a household income of less than NOK 299,000 (60% of the median income for households), which was approximately the poverty line in Norway in 2015 (Statistisk Sentralbyrå, 2016), compared to the national level of 13 % of household incomes below the poverty threshold. We chose to create a simple composite SES variable by adding maternal and paternal education levels and household income.

Table 1 Descriptive statistics of demographic variables

<table>
<thead>
<tr>
<th>Time</th>
<th>Variable</th>
<th>N</th>
<th>Scale</th>
<th>Min-Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>Education mother</td>
<td>228</td>
<td>1-5</td>
<td>1-5</td>
<td>3.32</td>
<td>1.30</td>
</tr>
<tr>
<td></td>
<td>Education father</td>
<td>226</td>
<td>1-5</td>
<td>1-5</td>
<td>2.86</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>Household income</td>
<td>223</td>
<td>1-10</td>
<td>3-10</td>
<td>8.49</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>SES</td>
<td>220</td>
<td>0-22</td>
<td>8-20</td>
<td>14.71</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>229</td>
<td>Year</td>
<td>5.29-6.30</td>
<td>5.78</td>
<td>.28</td>
</tr>
<tr>
<td>Time 2</td>
<td>Education mother</td>
<td>228</td>
<td>1-5</td>
<td>1-5</td>
<td>3.32</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>Education father</td>
<td>226</td>
<td>1-5</td>
<td>1-5</td>
<td>2.86</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>Household income</td>
<td>221</td>
<td>1-10</td>
<td>2-10</td>
<td>8.75</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>SES</td>
<td>219</td>
<td>0-22</td>
<td>6-22</td>
<td>15.02</td>
<td>3.56</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>229</td>
<td>Year</td>
<td>6.29-7.30</td>
<td>6.78</td>
<td>.28</td>
</tr>
</tbody>
</table>

SES, socio-economic status
2.3 Approvals and Ethics

Both the main study and our project has been reported to, and approved by, The Norwegian Centre for Research Data (NSD). This included the approval of the information about the project to parents, all content and methods of collection of questionnaires and tests. It included the sharing of data with us at University of Oslo (UiO) as an external institution, for which we had an official written agreement. Prior to sharing data, the material was partly coded and anonymized. All names, contact information, and directly identifiable information of the parents and children were removed. Teachers and kindergarten caretakers’ names were replaced with a numerical code. However, birthday information on the children had to be kept, as age was included in the study design. This information could possibly identify participants considering the relatively small size of Klepp municipality. The data material was therefore treated with caution and the level of security required by sensitive data. Data was personally transferred via an encrypted memory stick, worked on exclusively at UiO’s secure home area, and shared through, and stored at and UiO’s Service for Sensitive Data (TSD) – a platform that handles sensitive data in compliance with the Norwegian regulation regarding individuals’ privacy.

2.4 Measurements

2.4.1 Strengths and difficulties questionnaire.

The Strengths and difficulties questionnaire (SDQ) is a well-known report form used to assess mental health, peer relations, and prosocial behavior in children aged 4 – 17 years (Goodman, 1997). SDQ contains 25 items organized in the five subscales, where the first four are summed to generate a total difficulties score. Of these five subscales, we have chosen to focus on subscale peer relationship problems and prosocial behavior as these factors are considered to reflect the construct of social adjustment.

The five items of the peer relationship problems scale:

- Rather solitary, prefers to play alone
- Has at least one friend (reversed scoring)
- Generally liked by other children (reversed scoring)
- Picked on or bullied by other children
- Gets on better with adults than other children
The five items of the prosocial scale:

- Considerate of others peoples feelings
- Shares readily with other children
- Helpful if someone is hurt
- Kind to younger children
- Often volunteers to help others

Numerous international studies have examined the psychometric properties of the parent, teacher, and self-rated versions of SDQ, and concluded that it provides good construct validity and adequate to high reliability (Achenbach et al., 2008; Goodman, 2001; Stone, Otten, Engels, Vermulst, & Janssens, 2010). In most studies the teacher rated SDQ (SDQ-T) showed internal consistency and test-retest reliability on par with or higher than parent rated SDQ (SDQ-P), and higher than self-rated SDQ (SDQ-S) (Stone et al., 2010). The results from Stone and colleagues review (2010) also indicate that parent ratings contain less trait variance than either teacher or peer ratings. Our SDQ-P and SDQ-T data supported this finding by demonstrating that SDQ-P showed lower variance, especially on the prosocial scale. The data material from SKOLEKLAR included both SDQ-P and SDQ-T, but we chose to use SDQ-T data in our analyses based on the reasons above. SDQ-T was scored by kindergarten caretakers at the first measurement, and by schoolteachers the following year when at the end of first grade in school. The Norwegian translation of SDQ, called “Svake og Sterke sider”, was used. Expected group differences and confirmatory factor analysis of the Norwegian version supports the construct validity of this instrument, confirming adequate to good internal consistencies of the subscales as well (Kornør & Heyerdahl, 2014).

### 2.4.2 Electronic gaming.

The use of electronic games was measured by three parent reported questions:

*How many hours per week does your child use on the following activities?*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of hours per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer games/Video games (Wii, PlayStation and such.)</td>
<td>_______ hours</td>
</tr>
<tr>
<td>Internet (children’s webpages, games, tasks and such)</td>
<td>_______ hours</td>
</tr>
<tr>
<td>Mini-games (Nintendo DS, telephone games and such)</td>
<td>_______ hours</td>
</tr>
</tbody>
</table>
Time spent on internet websites was included as a part of electronic gaming based on the assumption that webpages targeting 5–7 year old children mostly provided interactive tasks of some sort. This as opposed to the passive behavior of watching movies or videos which also was included in the original survey, but excluded in our study. Time spent on internet websites was low relative to computer games and mini-games. Parents were asked to answer in terms of whole and half hours, for example 7.5 hours or 10 hours. The scores were summed and each participant’s total time was used as the measure of electronic gaming in our analyses.

2.5 Statistical Methods

Statistical analyses were performed using SPSS V.24. and AMOS v.8. Cross-lagged path modeling was conducted to simultaneously address associations and directionality of electronic gaming and the social adjustment variables. Cross-lagged path models compare cross-lagged relationships ($Y_1 \rightarrow X_2, X_1 \rightarrow Y_2$). In addition to allowing for the calculation of cross-lagged effects, cross-lagged path models also control for correlations within time-points and for the effect the variables have on themselves, i.e. autoregressive effects (Schuurman, Ferrer, De, & Hamaker, 2016). Autoregressive effects describe the amount of stability in constructs over time. Smaller autoregressive coefficients indicate more variance in the construct, meaning less stability or influence from the previous time point. Larger autoregressive coefficients indicate more stability or influence from the previous time point. The use of autoregressive cross-lagged modeling to examine change effects and reciprocal influences with regression is considered an appropriate method for studying possible causality in longitudinal data (e.g. Doest & Jonge, 2006; Marsh, 1990).

Figure 1 (see below) illustrates the autoregressive cross-lagged model computed in AMOS. Three additional constrained models were employed: one where path a was set equal to 0, the other where path b was set to equal 0, and a third constrained model where path a was set equal to path b. The relative fit of these three constrained models was calculated against the unconstrained main model. Hu and Bentler (1999) suggested that comparative fit index (CFI) and Tucker-Lewis Index (TLI) values above .95 and root mean square errors of approximation (RMSEA) values less than .08 represent acceptable fit. Model comparison was assessed using the chi-squared ($\chi^2$) statistic. A non-significant chi-squared test of difference indicates that the constrained model provides an equal fit to the data as the unconstrained
model. The value of RMSEA should be less than .05 for a model that fits well. Values of .06 to .08 indicate mediocre fit, and values greater than .10 indicate poor fit (Ridden, 1996; MacCallum & Browne, 1993).

**Figure 1** The cross-lagged model as employed in AMOS
3 Results

3.1 Preliminary Analyses

3.1.1 Missing data.

Due to the SKOLEKLAR projects close collaboration with the municipality and the kindergartens, missing data for each variable was generally low, from 0 to 5.80%. Across all variables included in this study the rate of missing values was only 1.10%. In addition to item non-response, which occurs when a participant skips individual questions, there were a total of thirteen cases of loss of follow-up, either missing completely or not obtained at time 2. Of these thirteen missing data cases, two cases were missing completely at time 1, while eleven cases were missing completely or had only teacher informed data, but not parent informed data at time 2. As within-subject and between-subject comparisons are inherent in our analysis, all the thirteen participants with first or second wave non-response were removed from our dataset prior to further analyses.

According to Rubin’s (1976) categorization of missing data, the three types of missing data is a) Missing Completely at Random (MCAR) – when missingness is not dependent on values in the data set, b) Missing at Random (MAR) – when missing values is not related to the participants own score on the same variable but may be explained by the other variables, and c) Not Missing at Random (NMAR) – when the MAR assumption is violated. We used Little’s test-to-test MCAR assumptions. The test did not show a significant p-value \( p = .178 \), which indicated that MCAR might be assumed (Little, 1988), i.e. that missingness is assumed not to matter for the analysis. This was probably due to the overall low rate of missing value.

Considering our MCAR data together with our relatively large sample, Maximum Likelihood method with single imputation conducted in AMOS was chosen to deal with missing data. Since maximum likelihood method does not automatically impute data, this was done by an additional command in AMOS. A new imputed dataset was created and feeded back to SPSS. The imputed values was then manually replaced with the closest value within the scoring limits set for that specific variable, e.g. an imputed -.28 score on electronic gaming was changed to 0 because negative score was not within the scoring range of this variable; an imputed 10.60 score on the prosocial scale exceeded the range of 0 – 10 and
consequently was changed to 10. Earlier studies have shown that the Maximum Likelihood method performed better than different types of multiple imputations under MCAR and MAR conditions in longitudinal studies with non-normal data (Shin, Davison, & Long, 2017).

3.1.2 Distribution of data.
We used the Shapiro-Wilk test in SPSS to check distributions for normality (Garson, 2012; Razali & Wah, 2011). The test showed statistical significance for all electronic gaming and social adjustment variables at both time points, suggesting that data was not normally distributed (p = .000). Visual graphical data showed that most distributions were heavily skewed towards the right for most variables except SDQ prosocial, which was skewed to the left. Time 1 (T1) variables was more skewed than time 2 (T2) variables, this was especially true for frequency of electronic gaming. For the latent variables, skewness and kurtosis values were above +/- 2 both before and after removal of outlier, indicating insufficient normality for multivariate tests. Consequently, nonparametric, or “distribution free” analyses were applied to calculate correlations (Bisharria & Hittner, 2012), as seen further down in table 3.

3.1.3 Outliers.
When distribution is skewed or non-normal, commonly used outlier labeling methods, as the box plot approach or the standard deviation method, may be less suitable as extreme values tend to inflate its intervals. We therefore chose to use the 3MADe method (3 MADe Method: Median ± 3 MADe) to identify outliers (Olewuezi, 2011). This method uses the median and the median absolute deviation, which is largely unaffected by extreme values in the data set. Since our distributions are non-normal we used factor e = 1/Q (.75), where Q (.75) is the .75 quantile of that underlying distribution. This outlier labeling method was performed on all electronic gaming variables and all social adjustment variables. One extreme outlier was identified and excluded.

With the removal of this participant, plus the thirteen 1st or 2nd wave non-response, we were left with N = 229 of the original 243 participants. Drop-out analysis was performed with independent samples test. No significant difference was found between the group of left-out participants and the included group on electronic gaming and social adjustment variables.
3.2 Descriptive Analyses and Correlations

Table 2 Descriptive statistics for main variables

<table>
<thead>
<tr>
<th>Time</th>
<th>Measure</th>
<th>Scale</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>Gaming</td>
<td>Hours</td>
<td>0-15</td>
<td>3.64</td>
<td>3.30</td>
</tr>
<tr>
<td>Kindergarten</td>
<td>Prosocial</td>
<td>0-10</td>
<td>0-10</td>
<td>8.20</td>
<td>2.13</td>
</tr>
<tr>
<td>N=229</td>
<td>Peer problems</td>
<td>0-10</td>
<td>0-7</td>
<td>.91</td>
<td>1.48</td>
</tr>
<tr>
<td>Time 2</td>
<td>Gaming</td>
<td>Hours</td>
<td>0-22.5</td>
<td>5.49</td>
<td>4.43</td>
</tr>
<tr>
<td>School</td>
<td>Prosocial</td>
<td>0-10</td>
<td>1-10</td>
<td>8.01</td>
<td>2.16</td>
</tr>
<tr>
<td>N=229</td>
<td>Peer problems</td>
<td>0-10</td>
<td>0-7</td>
<td>.75</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Table 2 reports descriptive statistics for the main variables. Results of paired sample t-tests showed that electronic gaming at T2 was significantly higher than T1 (p = .000), while the difference between the T1 and T2 means of prosocial behavior and peer relationship problems was not significant. Table 3 reports non-parametric correlations between all variables. As we might expect, all T1 variables are significantly correlated with the corresponding T2 variables, even when age, gender, and SES were controlled for. The table also shows that electronic gaming at T1 correlates significantly with prosocial behavior T2 (p = < .01), and electronic gaming at T2 correlated with both peer relationship problems T2 and prosocial behavior T2. However, these correlations were not significant when gender, age and socioeconomic status were taken into account. The partial correlation indicates non-significant cross-sectional correlation between electronic gaming and each of the two social adjustment variables. Of the control variables, gender was significantly correlated to all study variables, while SES was related to electronic gaming T2, prosocial behavior T1, and peer relationship problems T2. Age was not significantly correlated with any variables.
Table 3 Correlations between all study variables

<table>
<thead>
<tr>
<th></th>
<th>N=229</th>
<th>Gaming T1</th>
<th>Gaming T2</th>
<th>Peer problem T1</th>
<th>Peer problem T2</th>
<th>Pro social T1</th>
<th>Pro social T2</th>
<th>Age</th>
<th>SES</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaming T1</td>
<td>1.000</td>
<td>.568**</td>
<td>-.002</td>
<td>.077</td>
<td>-.037</td>
<td>- .188**</td>
<td>-.061</td>
<td>-.082</td>
<td>.277**</td>
<td></td>
</tr>
<tr>
<td>Gaming T2</td>
<td>.518**</td>
<td>1.000</td>
<td>.082</td>
<td>.145*</td>
<td>-.027</td>
<td>-.135*</td>
<td>.082</td>
<td>-.195**</td>
<td>.307**</td>
<td></td>
</tr>
<tr>
<td>Peer prob. T1</td>
<td>-.047</td>
<td>.026</td>
<td>1.000</td>
<td>.363**</td>
<td>-.281**</td>
<td>- .281**</td>
<td>-.074</td>
<td>-.119</td>
<td>.130*</td>
<td></td>
</tr>
<tr>
<td>Peer prob. T2</td>
<td>.026</td>
<td>.081</td>
<td>.336**</td>
<td>1.000</td>
<td>-.200**</td>
<td>-.420**</td>
<td>-.061</td>
<td>-.138*</td>
<td>.157*</td>
<td></td>
</tr>
<tr>
<td>Prosoc. T1</td>
<td>.060</td>
<td>.106</td>
<td>-.239**</td>
<td>-.141*</td>
<td>1.000</td>
<td>.306**</td>
<td>.046</td>
<td>.177**</td>
<td>-.275**</td>
<td></td>
</tr>
<tr>
<td>Prosoc. T2</td>
<td>-.095</td>
<td>-.006</td>
<td>-.247**</td>
<td>-.387**</td>
<td>.223**</td>
<td>1.000</td>
<td>-.051</td>
<td>.138*</td>
<td>-.305**</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
<td>.041</td>
<td>-.043</td>
</tr>
<tr>
<td>SES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
<td>.023</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
</tbody>
</table>

Bivariate Spearman's rho on upper half; partial correlations on lower half, controlled for age, SES, and gender; SES, socio-economic status; *p < .05; **p < .01

3.3 Electronic Gaming and Social Adjustment

To test research objective one; if electronic gaming T1 predicted change from T1 to T2 in the two variables of social adjustment (path a), and research objective two; if the social adjustment variables predicted change in hours spent on electronic gaming (path b), analyses on the default model (figure 1) was calculated. We found no significant associations between electronic gaming frequency and SDQ peer relationship problems, as shown in table 4 (see further down). For electronic gaming frequency and the prosocial scale we found a significant association on path a: gaming T1 → SDQ prosocial T2 (β = -.195, p = .002), but not path b: SDQ prosocial T1 → gaming T2 (β = .056, p = .278), as shown in table 5 (see further down). This indicates that prior electronic gaming frequency was related to a
subsequent decrease in prosocial behavior, but preconditioned prosocial behavior was not significantly related to subsequent change in electronic gaming frequency.

To examine possible reciprocal effects of the two lagged relationships and determine directionality, as stated in research objective three, the default cross-lagged model of electronic gaming and SDQ prosocial was compared with the constrained model Path $a = \text{Path b}$. Comparison indices showed that the Path $a = \text{Path b}$ model was significantly different from the unconstrained default model. This result indicates that the two paths are significantly different to each other. These findings was further supported by the chi-square test (table 6; see below) indicating that the constrained Path $a = 0$ model deviated significantly from the unconstrained default model. This means that a model where the association between electronic gaming T1 and prosocial behavior T2 is 0 does not fit the data. The Path $b = 0$ model did not deviate significantly from the unconstrained model. This tells us that the effect of prosocial behavior T1 on electronic gaming T2 is not significantly different from 0, i.e. there is no association. The model comparisons showed that the Path $b = 0$ model was the only one of the constrained models with acceptable fit indices. All of these results points to the conclusion that the direction of influence goes from electronic gaming to prosocial behavior, with no reciprocal effects. For electronic gaming and peer relationship problems, none of the constrained models were significantly different from the default model and all exhibited acceptable fit indices compared to the default model, which confirmed both cross-lagged associations were close to 0.

Consistent with the bivariate correlations the cross-lagged estimates showed that gender was significantly related to both peer relationship problems and prosocial behavior, and to electronic gaming frequency. Boys play more electronic games at both time points and were rated to show less prosociality and have more problems with peers than girls. SES was only significantly related to T2 electronic gaming and T2 prosocial behavior, while age was not significantly related to any variables.
<table>
<thead>
<tr>
<th>Table 4 Regression weights for cross-lagged model of electronic gaming frequency and SDQ peer relationship problems scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimates</strong></td>
</tr>
<tr>
<td>Gender → T1 Peer problems</td>
</tr>
<tr>
<td>Gender → T1 Gaming</td>
</tr>
<tr>
<td>SES → T1 Gaming</td>
</tr>
<tr>
<td>SES → T1 Peer problems</td>
</tr>
<tr>
<td>AGE → T1 Gaming</td>
</tr>
<tr>
<td>AGE → T1 Peer problems</td>
</tr>
<tr>
<td>T1 Gaming → T2 Gaming</td>
</tr>
<tr>
<td>T1 Gaming → T2 Peer Problems</td>
</tr>
<tr>
<td>T1 Peer prob. → T2 Gaming</td>
</tr>
<tr>
<td>T1 Peer prob. → T2 Peer prob.</td>
</tr>
<tr>
<td>Gender → T2 Peer Problems</td>
</tr>
<tr>
<td>Gender → T2 Gaming</td>
</tr>
<tr>
<td>SES → T2 Peer problems</td>
</tr>
<tr>
<td>SES → T2 Gaming</td>
</tr>
<tr>
<td>Age → T2 Gaming</td>
</tr>
<tr>
<td>Age → T2 Peer problems</td>
</tr>
<tr>
<td>**SES, socioeconomic status; *p &lt; .05; **p &lt; .01; *<strong>p &lt; .001</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5 Regression weights for cross-lagged model of electronic gaming frequency and SDQ prosocial scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimates</strong></td>
</tr>
<tr>
<td>Gender → T1 Prosocial</td>
</tr>
<tr>
<td>Gender → T1 Gaming</td>
</tr>
<tr>
<td>SES → T1 Gaming</td>
</tr>
<tr>
<td>SES → T1 Prosocial</td>
</tr>
<tr>
<td>AGE → T1 Gaming</td>
</tr>
<tr>
<td>AGE → T1 Prosocial</td>
</tr>
<tr>
<td>T1 Gaming → T2 Gaming</td>
</tr>
<tr>
<td>T1 Gaming → T2 Prosocial</td>
</tr>
<tr>
<td>T1 Prosocial → T2 Gaming</td>
</tr>
<tr>
<td>T1 Prosocial → T2 Prosocial</td>
</tr>
<tr>
<td>Gender → T2 Prosocial</td>
</tr>
<tr>
<td>Gender → T2 Gaming</td>
</tr>
<tr>
<td>SES → T2 Prosocial</td>
</tr>
<tr>
<td>SES → T2 Gaming</td>
</tr>
<tr>
<td>Age → T2 Gaming</td>
</tr>
<tr>
<td>Age → T2 Prosocial</td>
</tr>
<tr>
<td>**SES, socioeconomic status; *p &lt; .05; **p &lt; .01; *<strong>p &lt; .001</strong></td>
</tr>
</tbody>
</table>
Table 6 Model fit and comparison summary for electronic gaming and SDQ prosocial

<table>
<thead>
<tr>
<th>Model</th>
<th>CMIN</th>
<th>df</th>
<th>p</th>
<th>RMSEA</th>
<th>TLI</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default model</td>
<td>0</td>
<td>0</td>
<td></td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model a=b</td>
<td>4.450</td>
<td>1</td>
<td>.035</td>
<td>.123</td>
<td>.662</td>
<td>.984</td>
</tr>
<tr>
<td>Model a=0</td>
<td>9.100</td>
<td>1</td>
<td>.003</td>
<td>.188</td>
<td>.207</td>
<td>.962</td>
</tr>
<tr>
<td>Model b=0</td>
<td>1.175</td>
<td>1</td>
<td>.278</td>
<td>.028</td>
<td>.983</td>
<td>.999</td>
</tr>
<tr>
<td>Independence model</td>
<td>235.417</td>
<td>21</td>
<td>.000</td>
<td>.212</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

RMSEA, root mean square of approximation; TLI, Tucker-Lewis index; CFI, comparative fit index.

3.4 Additional Analyses

When the same cross-lagged analyses were done with all available data, and with maximum likelihood method in AMOS to deal with missing data, we did not find significant associations between electronic gaming and any of the two social adjustment variables. The standardized estimate for the association T1 gaming → T2 prosocial was to -.119 (p = .066) when all available data was used.
4 Discussion

The goal of this study was to provide knowledge of the potential longitudinal associations between electronic games and social adjustment among children in transition from kindergarten to school. The results were mixed. Findings indicate that electronic gaming frequency was associated with prosocial behavior. The more children played electronic games in kindergarten, the less prosocial they became in first grade – taken into account the initial level of prosocial behavior in kindergarten. However, there were no significant association between electronic games and peer relationship problems. Also, no associations were found in the opposite direction, peer relationship problems or prosocial behavior levels in kindergarten did not predict change in amount of hours spent on electronic gaming in first grade. Furthermore, cross-lagged analysis showed support for a one-directionality relationship, that electronic gaming predicts prosocial behavior and not vice versa.

4.1 Electronic Gaming Predicting Change in Social Adjustment

Inconsistency in findings between the present study and previous research can be due to following issues: longitudinal design contra cross-sectional correlations, the use of a frequency measure of electronic gaming and not a categorization of the content, and younger age group in the present study versus older age group in most of previous research. The association between electronic gaming and prosociality found in the present study is in line with previous research demonstrating that electronic games have a negative influence on prosocial behavior, but these studies differs by the cross-sectional nature (e.g. Anderson & Bushman, 2001; Anderson et al., 2010). A systematic literature review of existing longitudinal studies has shown that the majority of the research studies have investigated effects of electronic gaming in adolescence or early adulthood (Anderson, Steen, & Stravopoulos, 2016). The most comparable study is Lobel et al. (2017) two-wave longitudinal cross-lagged study. They used SDQ subscales and found an association between gaming and internalizing problems, but not between gaming and prosocial behavior, nor between gaming and peer relationship problems. However, the children who participated in this study are still one to two years older than in the present study.

Age plays an essential role to the development of social skills. Throughout infancy and childhood, children develop an increasingly refined understanding of others’ emotional states and cognitive processes (Eisenberg & Fabes, 1998; Eisenberg et al., 2015). Support of
age-related changes in the research literature suggest that prosocial behavior increase significantly within both the infant years and the preschool years (3 – 6 years), while it appears to be stable or decline in middle childhood and pubertal years (e.g. Eisenberg et al., 2015). This may be an indication of the early childhood years being especially important for development of prosocial behavior skills. Hence, electronic gaming may have more impact on development of prosocial behavior in children during these years, relatively compared to older school children.

The age factor can also possibly explain why electronic gaming did not predict peer relationship problems. Although electronic games can be viewed as a modern play that can provide similar positive context for children’s social development (Adachi & Willoughby, 2017), one of the key points in Vygotsky’s learning theory is that children’s development is socially conditioned (Vygotsky, 1978). In our study, children are in transition from kindergarten to school, and children at that age might be more dependent on the family. What the families provide in terms of social activity can play a greater role than electronic games in kindergarten affecting social adjustment among children in this age group (Knafo & Plomin, 2006). Additionally, children may have less autonomy and parental mediation is likely to be higher the younger the children are. This can be some of the explanations of why the results of our study were mixed. Peer relationships problems may be a more suitable measure of social adjustment for older school children, as it becomes of more importance of the older school children and adolescents during development of identity and social belonging (Anderson, 2004; Anderson & Bushman, 2001; Anderson et al., 2004; Anderson et al., 2010; Durkin, 2006; Sherry, 2001).

The mixed results in the present study are noteworthy. Although prosocial behavior and peer relationship problems do correlate significantly both on T1 and T2, the two variables do not show similar results in relation to electronic gaming. Another possible explanation could be that our study does not take into account the selection that occurs internally in the sample, where children who play often tend to choose friends with the same area of interest (Newcomb & Bagwell, 1995; Rutter, 2006). Similarly, studies have shown that children tend to select friends who match themselves according to prosocial and anti-social traits (Eivers, Brendgen, Vitaro, & Borge, 2012). On that background, the absence of peer relationship problems in T1 and T2 can be understood as the result of a selective development process, where a possible effect of electronic games does not manifest itself because of the children’s mutual selection and rejection of friendships. This selection mechanism could thus be understood as a lurking or extraneous variable that affects the
connection between electronic games and peer relationship problems (Agresti & Finlay, 2014). According to Sameroff (2009), transactions occur constantly and everywhere, making the researching and covering of isolated phenomena more difficult because the transactional process is omnipresent and thus cannot be delimited. When applied to our study, this framework of understanding can shed light on the mixed results in a development-specific way. The absence of peer relationship problems may be understood as the result of an adaptive transactional process where children with impaired prosocial abilities manage to compensate for their weakened skills.

Alternatively, a suppressor variable could cause the lack of association, where the association between electronic games and peer relationship problems is absent until a third variable is examined (Tzelgov & Henik, 1991). A possible bid for such a variable could be siblings, which previous studies have shown are negatively associated with peer problems, but positively influence the extent of siblings' gaming habits – provided that the relationship is good and that they play electronic games (Cutting & Dunn, 2006; Edwards et al., 2015; Graham-Berman & Gesta, 1991; McHale, Updegraff, & Whiteman, 2012). The reason we do not see a relationship between electronic gaming frequency and peer relationship problems, is maybe because typically children with siblings tend to have less peer relationship problems, and peer relationship problems are positively related to gaming frequency.

Most of the studies from different meta-analyses have investigated the content of electronic games rather than the frequency of electronic gaming (e.g. Anderson & Bushman, 2001; Greitemeyer & Mügge, 2014). On the contrary, the present study has chosen a general measure of electronic gaming, and not differentiated between types of electronic, nor measured the games by content. A categorization of violent or prosocial electronic gaming content will may be more directly relatable to children’s social adjustment skills compared to general electronic gaming frequency (Lobel et al., 2017). On the other hand, because children in the present study were in transition from kindergarten to school, a higher degree of parental mediation was assumed (Nikken & Jansz, 2006). It is therefore more likely that early school-age children play fewer electronic games with antisocial or violent content than older school-age children. This could possibly cause a problem with variation. Another challenge of measuring electronic game content is the lack of validated standardized assessments of the categorization of content in electronic games (Lobel et al., 2017). Coding electronic games the younger school children play would likely be on different premises, since the social and antisocial features of those games may differ from the games played by older school children and adolescents. Highly violent graphics, or first person shooting, might not be as prevalent,
nor would multiplayer co-operation. Furthermore, one child is likely to play several different kinds of electronic games, as different kind of electronic games are prominent features of children’s home environments in many high-income countries (Parkes et al., 2013). Besides, modern electronic games encompass a highly diverse set of interactions, and even electronic games within the same genre may engage players in diverse ways (Granic et al., 2014). It is plausible that electronic games children in between 5 – 7 years of age is likely to play, contain a mixture of more or less age-appropriate prosocial or antisocial features simultaneously, making it more difficult to disentangle the various features.

4.1.1 Social learning theory & Affective perspective-taking.

Social learning theory (Bandura, 1977) and affective perspective-taking (Eisenberg et al., 2016) can offer explanations of the association between electronic gaming and social adjustment skills. Applying the theories to our topic, electronic gaming might deprive the child of important opportunities to observe and thereby learn and model social behavior. Also, electronic gaming may restrict direct interaction with parents and peers, which can be a contributory factor to delaying or limiting the attainment of APT. A number of studies have demonstrated a reciprocal positive association between APT and prosocial behavior (Imuta, Henry, Slaughter, Selcuk, & Ruffman, 2016). On this basis, the negative association between electronic gaming and prosocial behavior as measured by T1 and T2 may be caused by a reduced ability to take others’ perspectives, which are necessary requirement for prosocial behavior. In a transactional process, this can create a shift in development, leading to a more differentiated course of development.

There are studies supporting the notion that hour spent on electronic gaming deprives the child of valuable social time (e.g. Uhls et al., 2014). If children playing electronic games actually interact less with their peers and family, the negative effects of electronic gaming can potentially be reverse by more face-to-face interaction. The implication is that it may not be electronic gaming or screen use per se that is harmful for social adjustment development, but the lack of direct social interaction. This in turn may explain why studies like Kovess-Masfety and colleagues (2016) concluded with a positive effect of gaming, when several covariates that possibly could be correlated with amount of social interaction, were controlled for. Future studies should therefore examine how time on social interaction relates to social adjustment skills and electronic gaming.
4.2 Social Adjustment Do Not Predict Electronic Gaming Outcomes

In our study there is no significant finding of social adjustment skills predicting change in hours spent on electronic games among children in transition from kindergarten to school. Self-determination theory has been used as one of the main theories as to explain why children seek to play more electronic games (Deci & Ryan, 2011). In Olson study’s (2010), children’s motivation for playing electronic games in the context of normal development were based on social and emotional motivations, such as the opportunity to making friends and experimentation with different identities. Children who have higher level of social adjustment skills, seek to play electronic games, because of the social motivations (Ryan et al., 2006), and children with poorer social adjustment skills might play more electronic games, because electronic games can be used as a source of solace or as an alternative to peer interaction (Carrington, Papinczak, & Templeton, 2003; Church, Alisanski, & Amanullah, 2000; Winter-Messiers, 2007). Specifically children with developmental disorders, who often have poorer social adjustment skills compared to children with no developmental disorders, are in greater risk of playing more electronic games (Durkin, 2010; Mazeurek & Engelhardt, 2013). Electronic games and virtual environments can therefore, for some children with poor social adjustment, provide a comfortable environment for role-playing behaviors that are challenging in an actual social context (Gelfond & Salonius-Pasternak, 2005; Griffiths, 2003). However, the results in the present study could not support this hypothesis.

4.3 The Directionality of Electronic Games and Social Adjustment

Our results shows that there is a significant difference between the two cross-lagged relationships, and that the influence from prior electronic gaming frequency to later change in prosocial behavior is stronger than between prosocial behavior T1 to electronic gaming T2. The latter association did not deviate significantly from 0. Thus, the directionality of influence between the two variables is mostly one-directional, with a minimal reciprocal effect. Our finding is in line with Lobel et al.’s study (2017), but are in contrast to studies that have concluded an indication that social adjustment may affect electronic gaming (e.g. Sakamoto, 1994). The results in the present study are also in contrary to studies that have shown a reciprocal relationship between electronic gaming and social adjustment, where the
influence can go both ways (e.g. Davidov et al., 2015). A conclusion of one-directionality does not support a reciprocal influence, but it does not necessarily rule out a possible transactional effect in this case. The children in this present sample may be at a stage where they have just been introduced to electronic games, and a transactional process may have started. However, it may need longer time to manifest in the data. Inconsistent results in the research on directionality of electronic games and social adjustment may also be caused by other differences in sample related or measurement related characteristics, and/or differences in the designs and statically methods used to examine the directionality. This will be discussed below.

4.4 Strengths and Limitations

4.4.1 The design and analytic method.

The majority of past research within this field has been with cross-sectional and experimental designs (Anderson & Bushman, 2001). Because cross-sectional studies have limited ability to draw valid conclusions about directionality and causality, and experimental results have limited external validity, the lack of longitudinal studies has been raised as an issue (Ferguson, 2011). The longitudinal design of the present study makes it an important contribution to the field. A methodological limitation, however, is that there were only data on two time points, which is the most basic form of cross-lagged designs. Two-waves can give us an idea of the directional effects, but might not be sufficient to obtain detailed information on how processes unfold over time.

In addition to the longitudinal design, the main strength of our study is the use of cross-lagged structural modeling to examine change processes in the observed variables. Unlike previous longitudinal work where the predictive value of T1 variables on T2 variables is established with correlations (Greitemeyer & Münge, 2014), cross-lagged structural modeling as done in the present study includes autoregressive effects. This means that the variance in Y2 that can be predicted by X1 is residual variance controlling for previous levels of Y1. When prior levels of the outcome variables are controlled for, the possibility that a cross-lagged effect is simply due to the fact that X and Y were correlated at T1 can be ruled out (Cole & Maxwell, 2003).

Even though cross-lagged models are an acknowledged method, there are a few fundamental issues worth mentioning. Most of them have to do with the fact that statistical
models will deviate from psychological, or real life, models in different ways. This often leads to violations of the underlying assumptions of the statistical models, which might distort results and threatens validity (Selig & Little, 2012). Several of these issues concern our study, and we will focus on four specifically related to cross-lagged designs and our study.

First of all there is the problem with possible omitted variables and the inference of causality. By measuring variables over time, cross-lagged designs can satisfy temporal precedence of the putative cause variable – a fundamental requirement in causal inference. As a result of this, cross-lagged designs have been used as an analytical strategy to support causal claims in longitudinal studies (Selig & Little, 2012; Newsom, 2015). But, as is the case with most methods in psychological research, there is no way to exclude potential confounding variables, or spurious effects. The present study has included the demographic variables of gender, age and socioeconomic status, the most common covariates within this field of research. However, some other studies have also included siblings (e.g. Kovess-Masfety et al., 2016), and other risk factors such as family violence, negative life events, family attachment and neighborhood problems (Ferguson, 2011). Other potential covariates could be the child’s extrovert traits or level of social orientation, parents’ level of prosocial behavior, or parents’ own behavior and attitude towards use of electronic devices (e.g. Przybylski & Weinstein, 2016). Given the uncertainty surrounding other possible variables with effect on development of social adjustment skills and electronic gaming frequency, interpretations of our cross-lagged panel analysis should be understood as directions of influence rather than causality until a much broader examination of the effect has been done in order to build an argument for inference of causality.

Second, normality is an issue because it is one of the basic assumptions required in order to carry out structural equation modeling analysis (SEM) (Byrne, 2016). Data in the present study has non-normal distribution, as most data in social sciences (Barnes, Cote, Cudeck, & Malthouse, 2001). Under violation of distributional assumptions, the chi-squared statistic become overestimated, potentially leading to false rejection of the model as whole, and standard errors of parameter estimates becomes underestimation, leading to inflated statistics and hence possibly erroneous attributions of significance of specific relationships in the model (Bentler & Chou, 1987; Gao, Mokhtarian, & Johnston, 2008). Large sample size may lead to reduction of the problem (Hair, Black, Babin, Anderson, & Tatham, 2006).

Third, cross-lagged models generally lack theories of change, as autoregressive parameters account for stability for everyone across time. The assumptions of stability
include both rank stability of participants and construct stability of variables. With humans as study objects there will always be varying degrees of stability, though very few methodological theories offers guidance in this area. Hertzog & Nesselroade (1987) address this issue in the critique of autoregressive models. They maintain that the problem with autoregressive effects is that they describe stability in individual differences but do not describe within-person stability for the measured variable. This naturally poses an even bigger problem when we are studying children as opposed to fully developed adults, because what we deal with is actually a change process nested in another larger developmental change process. Age and gender might to a degree account for developmental change, but only as far as a theory of universal psychological developmental trajectory can be defended.

The last issue concerns the underlying assumption that a proper time lag has been chosen, meaning that sufficient time has passed for a lagged predictor to have its effect on the outcome. Measurement intervals that are too short or too long in relation to the nature of the phenomenon being studied can produce data that in some cases are overly sensitive to measurement errors and, in other cases, are insensitive to variability and change in the system (Boker & Nesselroade, 2002; Gollob & Reichardt, 1987; McArdle & Woodcock, 1997). If the lag is too short, measurement will occur before the effects can be observed. If the lag is too long, the effects will dissipate before the next time of measurement. The length of a proper time lag might not be the same for different psychological variables, and might also vary with age. Thus, there is a chance that the mixed results in the present study is caused by the time lag of one year being sufficient for detecting changes in prosocial behavior but not in peer relationship problems. The different length of lags used between studies also complicates cross-study comparisons of similar effects. As a solution to this problem, variable lag designs – in which time lags are included in the panel design as predictors, has been explored (Selig & Preacher, 2009; Selig, Preacher, & Little, 2009), but such models require lag between measurements to vary between participants (McArdle & Woodcock, 1997).

4.4.2 The study sample.

Our sample consists of one cohort of five years old children from Klepp, in Norway. The relatively large sample size and the low missing rate is an important strength of the present study. Our population based sample makes our results more generalizable, but with non-clinical samples variation might be a problem. In the present study, the peer relationship
problems variable showed lowest variation of the two measures on social adjustment. As reported in table 2, the mean of peer relationship problems variable was low as .91 at T1 and .75 at T2. A floor effect was apparent in the peer relationship problems variable as 144 participants (62.90%) had a score 0 at T1 and 150 (65.50%) at T2. Ceiling effect was apparent in the prosocial behavior variable, with 96 (41.90%) participants with a top score of 10 at T1 and 80 (34.90%) had top score at T2. A clinical sample would yield more variation, but so could probably an older age group, as parents may have more influence on younger children’s friends and social time, and/or young children might not be so selective when it comes to playmates.

Klepp has just above 15,000 inhabitants and is considered an important area for farming, agriculture and industry related to agriculture in Norway. Children from the larger cities of Norway might differ in their pattern of electronic gaming and/or social behavior. However, the minority percentage in Norway in 2014 was 14% (Statistisk sentralbyrå, 2014), and the higher education percentage was 29.20% for men and 36.50% for women in 2017 (Statistisk sentralbyrå, 2017), which is similar to the percentages in our sample. Thus, generalization to a national level can be justified, but must be done with some precautions regarding possible differences in urban city environments versus agricultural.

In a broader context, the Norwegian culture might have its own characteristics affecting both the use of electronic gaming and psychosocial development. Earlier research has demonstrated large national differences in gaming frequency (e.g. Kovess-Masfety et al., 2016) and results from big datasets with population based samples reveals that Norwegian children score lower on the SDQ problem scales than for example the British norms (Kornør & Heyerdahl, 2014). Further cross-cultural studies are needed in order to generalize universally from the present study.

4.4.3 Measurements of variables.

**Electronic gaming.**

Other methodological issues concern measurements of the construct variables. The measurement of children’s electronic gaming in our study was a retrospectively approximately average estimation from the parents, which may differ a lot from actual electronic gaming frequency. In Lobel et al.’s study (2017), parental reported estimate of child’s average gaming frequency per week was accompanied by two different measurements.
on child reported estimate from the past week; one weekly total estimate and one recalled with the experimenter looking at the days on a calendar. Descriptive analyses showed that the calendar condition yield the highest mean gaming frequency (Lobel et al., 2017). This indicates that using visual stimuli to systematically recall as close as real time as possible might be a better measurement method of electronic gaming frequency. Closeness of actual event and reporting is generally better as memory tend to be distorted with time. An even better choice of measurement would be objective or automatic real time measurement, but that might require advanced technology and additional research resources.

**Social adjustment.**

In the present study, social adjustment is operationalized in terms of one positive measure of prosocial behavior and one negative measure focusing on peer relationship problems. Both are psychometric questionnaire reports and both are behavioral measures with five items each. They are significantly correlated but do not produce the same results in relation to electronic gaming. Electronic gaming might affect prosocial behavior specifically, but there is also a chance SDQ-T subscales is not an adequate measure of true prosocial behavior and/or peer relationship problems in children in this sample. As seen in table 5, the standardized autoregressive estimate for prosocial T1 → prosocial T2 is relative low (.235), indicating low level of stability from T1 to T2. This could have been an effect of gaming, but it could also be due to the fact that the rater was two different persons at first and second measurement.

SDQ is a popular standardized measure of children’s general psychosocial well-being. The questionnaire has shown high reliability and validity, especially the teacher rated versions (Stone et al., 2010). However when looking at the subscales separately, reliability and validity of each subscales varies. A large review with results from 48 studies on over 130,000 children aged 4 – 12 years showed that reliability and validity of prosocial behavior scale were high, but that inter rater agreement was lowest for prosocial behavior (Stone et al., 2010). Compared to the other subscales teacher rated peer relationship problems had lowest factor loadings when testing for construct validity, and lowest alpha when testing for internal consistency on both parent and teacher version. The authors pointed out that in their opinions only one of the five items in the peer relationship problem scale actually measured problem behavior. Thus, they questioned whether the five items reflect the same construct.

On a higher level, the mixed results could also imply that peer relationship problems reflects social adjustment poorly, or that social adjustment spans too wide to be treated as a
unified overarching construct. Therefore to fully investigate the issue of electronic gaming and social adjustment, inclusions of other aspects of social adjustment and other data collecting methods, is crucial. Examples of alternative measurement methods are observation or direct testing, and examples of other relevant aspects of social adjustment are ToM related skills (Wellman, Cross, & Watson, 2001), or social self-regulation skills (Raver et al., 2012).

4.5 Conclusion

This study is the first one in Norway to assess the potential influence of electronic gaming frequency and social adjustment skills among early school-age children. The results demonstrated that prior higher electronic gaming frequency is related to a subsequent lower degree of prosocial behavior. This finding supports the notion that electronic gaming influences children’s social adjustment negatively. There is, however, no significant association between gaming and peer relationship problems. Reasons to account for the mixed results could be low variability and construct validity of the peer problem scale, and/or selective or compensative processes. The use of peer problems as an appropriate latent variable of social adjustment in this age group can also be questioned, as younger children are likely to have less autonomy and more parental mediation when it comes to friends and playmates. Future studies should therefore consider including other aspects of social adjustment and other types of measurement, to examine why these mixed results occur.

Support for the notion that lower degree of social adjustment may lead to a higher amount of gaming was not found, as levels of prior social adjustment skills did not seem to affect change in hours spent on electronic games. The difference between the two directions of associations was significant, with a stronger influence from prior electronic gaming frequency to later change in social adjustment than vice versa. This finding indicates one-directionality and does not support the notion of reciprocal effects. This may, however, be caused by factors related to the age of participants. Age as a factor could be tested in longitudinal research by following a cohort of children over several years, to further investigate development issues.

In addition to total electronic gaming frequency, distinguishing between different forms of electronic games is one of the issues that must be included to further our understanding of how exactly electronic gaming can impact on children’s social adjustment. This means that researchers should strive to arrive at a validated standard for coding electronic game content. They must, however, take into consideration the fact that antisocial,
co-operational, or competitive content differ between electronic games for different age groups.

We also stress the importance of a closer examination of potential underlying mechanisms for the association between electronic gaming and social adjustment. Future research needs to distinguish between whether time spent on electronic games per se has a deteriorative influence on social adjustment, or if electronic gaming is harmful because it deprives the child of valuable social interaction with people in real life.

The association between electronic gaming and prosocial behavior found in the present study is an important contribution to the field, due to the longitudinal cross-lagged design, the large sample size with low missing rate, and the young age group studied. Limitations of this study concerns the study design, the cultural context of the sample, and the operational measurement of the latent variables. For broader generalizations, and a more comprehensive insight into the association of electronic gaming and social adjustment, future research will need to apply more complex study designs, cross-cultural comparisons, and include other aspects of social adjustment across data collection methods.

Our hope is that the findings in the present study can contribute to prevention- and psycho-educational work among parents, health professionals, educational leaders, teachers, and the general public. Development of prosocial behavior is an integral part of becoming socially well adjusted, which is of great importance to the individual child, as well as for our society at large. Any activity that possibly jeopardizes the advancement of these crucial relational skills should be monitored closely. We therefore need to examine further the effects of electronic games on our children, especially young preschool and school children who are in the steepest and most vulnerable part of their social development.
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