The Prevalence of Physical Aggression in Canadian Children: A Multi-Group Latent Class Analysis of Data from the First Collection Cycle (1994-1995) of the NLSCY

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Raymond Baillargeon, Richard E. Tremblay,
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Applied Research Branch
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Abstract

Physical aggression affects a significant segment of the Canadian population of children. Using data from the first collection cycle of the National Longitudinal Survey of Children and Youth, the authors have estimated at 3.5 the percentage of 2- to 4-year-old children in the Canadian population who, according to the person most knowledgeable about the child, are physically aggressive. This percentage is nearly the same for boys between 5 and 11 years of age (3.3 per cent) whereas it is substantially lower for girls (0.6 per cent). Essentially, these children can be characterized by a propensity to manifest physically aggressive behaviours that are many times higher than that of other children of the same age and sex in the Canadian population.

These results have important methodological implications. They suggest that latent class analysis (LCA) could provide a unified framework for combining ratings on many behaviour symptoms to identify a set of mutually exclusive and exhaustive classes of individuals that differ markedly in their propensity to manifest the symptoms in question. Because LCA does that while taking into account the symptoms' lack of sensitivity and specificity, this type of analysis can be used to obtain unbiased estimates of the proportion of individuals in the population who belong to the various latent classes. Secondly, LCA can be used to predict latent-class membership for each individual based on his or her observed ratings. Thirdly, LCA can be used to compare the prevalence of behavioural or emotional problems across groups.

These results have important public policy implications. This study provides public health policy analysts, for the first time, with information as to the prevalence of physical aggression in the Canadian population of children 2 to 11 years of age. The authors believe that these prevalence estimates should help to evaluate the need for mental health services for physically aggressive children at the national level. Secondly, this study provides a clear operational definition of what constitutes a physically aggressive child in Canada in terms of his or her propensity to manifest physically aggressive behaviours. The authors further believe that this operational definition should help to design cost-effective prevention and intervention programs that are adapted to the needs of physically aggressive children in Canada. Thirdly, this study provides the means to identify physically aggressive children in Canada. The authors believe that these means should help to channel the scarce public resources for mental health services toward those most in need of them.

Résumé

Les agressions physiques touchent une portion importante de la population d’enfants canadiens. À partir des données recueillies dans le cadre du premier cycle de l’Enquête longitudinale nationale sur les enfants et les jeunes, les auteurs estiment que 3,5 % des enfants canadiens sont physiquement agressifs – selon les déclarations de la personne qui connaît le mieux l’enfant. Ce pourcentage, qui demeure sensiblement le même chez les garçons de 5 à 11 ans (3,3 %), est passablement moins élevé chez les filles (0,6 %). On pourrait dire que, fondamentalement, ces enfants se caractérisent par une propension à se montrer physiquement agressifs qui est de beaucoup supérieure à celle que l’on retrouve chez les autres enfants canadiens du même âge et du même sexe.

Ces résultats ont d’importantes répercussions méthodologiques, en ce sens qu’ils laissent entendre que l’on peut obtenir, grâce à l’analyse de structure latente (ASL), un seul cadre où combiner les cotes au regard de maints symptômes comportementaux (pour cerner un ensemble de catégories exhaustives et s’excluant mutuellement de personnes profondément différentes au niveau de la tendance à manifester les symptômes à l’étude). Comme l’ASL prend en compte le fait qu’aucune sensibilité/spécificité n’est associée aux symptômes, elle peut aboutir à des estimations non biaisées du pourcentage de personnes d’une population donnée qui font partie des diverses catégories latentes. On peut aussi avoir recours à l’ASL pour prévoir l’appartenance d’une personne donnée à une catégorie latente – à partir des cotes relevées. Enfin, l’ASL peut servir à comparer la fréquence de problèmes émotifs ou comportementaux – entre les groupes.

Ces résultats ont d’importantes répercussions en matière de politique gouvernementale. Pour la première fois, une étude offre aux analystes des politiques en matière de santé publique des renseignements quant à la fréquence des agressions physiques chez les enfants canadiens de 2 à 11 ans. Selon les auteurs, ces estimations devraient aider à évaluer les besoins, à l’échelon national, pour ce qui est des services de santé mentale à l’intention des enfants physiquement agressifs. Ensuite, la présente étude offre une définition opérationnelle claire de ce qu’on entend, au Canada, par « enfant physiquement agressif » – dans l’optique propension à adopter des comportements physiquement agressifs. Les auteurs sont en outre d’avis que cette définition facilitera la conception, au chapitre « prévention » et « intervention », de programmes rentables adaptés aux besoins des enfants canadiens physiquement agressifs. Enfin, l’étude donne les moyens d’identifier les enfants physiquement agressifs du Canada, ce qui, croit-on, devrait aider à aiguiller les ressources publiques restreintes, en santé mentale, vers ceux qui en ont le plus besoin.

Acknowledgements

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Executive Summary

Physical aggression affects a significant segment of the Canadian population of children. Using data from the first collection cycle of the National Longitudinal Survey of Children and Youth we have estimated at 3.5 the percentage of 2- to 4-year-old children in the Canadian population who, according to the person most knowledgeable about the child, are physically aggressive. This percentage is nearly the same for boys between 5 and 11 years of age (i.e., 3.3 per cent) whereas it is substantially lower for girls (i.e., 0.6 per cent). Essentially, these children can be characterised by a propensity to manifest physically aggressive behaviours that is many times higher than that of the other children of the same age and sex in the Canadian population.

These results have important methodological implications. These results suggest that latent class analysis (LCA) could provide a unified framework for combining ratings on many behaviour symptoms to identify a set of mutually exclusive and exhaustive classes of individuals that differ markedly in their propensity to manifest the symptoms in question. Because LCA does that while taking into account the symptoms' lack of sensitivity and specificity it can be used to obtain unbiased estimates of the proportion of individuals in the population who belong to the various latent classes. Second, LCA can be used to predict latent class membership for each individual based on his or her observed ratings. Third, LCA can be used to compare the prevalence of behavioural or emotional problems across groups.

These results have important public policy implications. First, this study provides, for the first time, public health policy analysts with very precious information as to the prevalence of physical aggression in the Canadian population of children 2 to 11 years of age. We believe that these prevalence estimates should help to evaluate the need for mental health services for physically aggressive children at the national level. Second, this study provides a clear operational definition of what constitutes a physically aggressive child in Canada in terms of his or her propensity to manifest physically aggressive behaviours. We believe that this operational definition should help to design cost effective prevention and intervention programs that are adapted to the needs of physically aggressive children in Canada. Third, this study provides the means to identify physically aggressive children in Canada. We believe that these means should help to channel the scarce public resources for mental health services toward those most in need of them.

1. Introduction

Physical aggression is an important concern for public health and human resource development. In this paper we use the term physical aggression to refer to physical acts oriented towards another person which could inflict physical harm. Although there have been numerous studies of children's aggressive behaviour, few studies have focused on the development of aggression. Researchers in this area have tended to aggregate physical aggression with indirect aggression, verbal aggression, opposition, competition, and even hyperactivity (Nagin & Tremblay, in press; Tremblay,1991; Tremblay et al., in press). Recent work on the differences between indirect aggression (e.g. trying to get others to dislike someone you do not like) and physical aggression has shown important age and sex differences in the expression of each of these type of aggressive manifestations (Björkqvist et al., 1992; Crick & Grotpeter, 1995; Lagerspetz, 1988; Tremblay et al., 1996). Physical aggression can be observed as soon as the end of the first year after birth (Tremblay et al., in press), while indirect aggression may appear only once children have acquired some insight into the complexity of social interactions and the means (usually verbal) to manipulate social interactions. Manifestations of physical aggression appear to change with age, and differently for boys and girls (Loeber & Hay, 1997; Loeber & Stouthamer-Loeber, 1998; Tremblay et al.,1996; Tremblay et al., in press).

Children who do not learn to inhibit physically aggressive behaviour during early childhood appear to be at higher risk of becoming the violent juvenile delinquent, the perpetrator of dating violence, the abusing parent and the abusing mate (Cairns & Cairns, 1994; Farrington, in press; Nagin & Tremblay, in press). From this perspective, children who have not learned to inhibit physical aggression are an important handicap for the development of human resources in our modern societies, and a major public health issue. To prevent the development of chronic problems with physical aggression, we need to have reliable means of identifying children at risk, and accurate estimates of the magnitude of the problem in the Canadian population. It is essential to achieve both of these goals if we want to develop effective strategies, policies and intervention programs to promote the healthy development of children in Canada. However, obtaining reliable estimates of the prevalence of physical aggression among children in Canada presents some difficult methodological challenges.

1.1 The Formal Diagnosis of Problem Behaviours and the Problem of an Arbitrary Cutoff Point

Making a formal diagnosis on the basis of a list of behaviour symptoms is one of these difficult challenges. The conventional approach used for the diagnosis of behavioural problems in children consists of using a cutoff point specified in terms of an arbitrary number of behaviour symptoms. This approach is also known as the categorical approach of making a formal diagnosis and is best illustrated by the assessment procedure specified by the American Psychiatric Association's (1994) Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). The clinician's make a yes-or-no judgement as to whether a child has a disorder based on a list of behaviour symptoms, and an arbitrary number is required to make a formal diagnosis. If the number of behaviour symptoms exceeds the minimum specified by the cutoff point then the child is said to have the disorder; otherwise, he or she does not. Another approach is the dimensional approach which consists of specifying an arbitrary cutoff point on a continuous scale that is the (weighted) sum of the observed ratings on the behaviour symptoms (for an illustration of this approach see Achenbach, 1981). Hence, although these two approaches represent different case definition strategies they both use an arbitrary cutoff point to distinguish between disordered and nondisordered individuals.

There are many problems associated with using an arbitrary cutoff point to make a formal diagnosis. First, because the cutoff point for number of behaviour symptoms in the conventional approach is dictated by prevailing custom rather than being systematically derived from research (for some recent attempts, see Lahey, Applegate, Barkley et al., 1994; Lahey, Applegate, McBurnett et al., 1994), it may well be that two diagnostic categories created by this procedure do not constitute homogeneous groups of children in the population. This is also a problem with the dimensional approach. As a result, there may be substantial inter-individual differences within the two categories—potentially useful information—that these two approaches simply chooses to ignore. Moreover, the potential lack of internal validity of the two diagnostic categories created by these two approaches may cause many problems when it comes to compare children from different diagnostic categories on external validating factors. For instance, it may be difficult interpret the results from studies aimed at validating the diagnostic categories using psychosocial factors, demographic factors, biological factors, family genetic factors, family environmental factors natural history, and response to therapeutic intervention if the internal validity of the diagnostic categories is unknown (Cantwell, 1996). Moreover, the conventional as well as the dimensional approach assume that the childhood disorder is either present or absent, although there may be more than two mutually exclusive and exhaustive categories of individuals in the population. For instance, children form a third diagnostic category may be subsyndromal for the disorder but nonetheless experience a considerable amount of functional impairment. Having these individuals mixed within the other two diagnostic categories would have the effect of reducing, if not annihilating, the correlation that may otherwise exist between the disorder and any external validating factor (Robins, 1985).

Second, the use of an arbitrary cutoff point in the conventional approach relies on the implicit assumption that all behaviour symptoms are equally good indicators of the behavioural or emotional problem in question. However, children who display the same number of behaviour symptoms do not necessarily constitute an homogeneous group of individuals.

Finally, the problem of using an arbitrary cutoff point is exacerbated by the common practice of using the same cutoff point, irrespective of the age or the sex of the child. As a result, any difference in the prevalence of the behaviour symptoms between, let say, boys and girls, is interpreted within the conventional approach as a true difference in the prevalence of the behavioural or emotional problem in question. However, part if not all of the observed differences in the prevalence of the behaviour symptoms between boys and girls may be due to the fact that the behaviour symptoms are not functioning in the same way for the two groups (i.e., the propensity to manifest the behaviour symptoms for a given diagnostic category may well vary between the two groups). In contrast, any difference in the prevalence of the behaviour symptoms between boys and girls is interpreted as differential symptom functioning within the dimensional approach. However, part if not all of the observed differences in the prevalence of the behaviour symptoms between the two groups may be due to a true difference between the two groups in the prevalence of the behaviour or emotional problem in question. Hence, these two approaches for making a diagnosis hampers the achievement of one of the main objectives of developmental epidemiology, which consists of comparing estimates of the prevalence of behavioural or emotional problems in childhood across groups of children who may differ in age or sex. Therefore the conventional as well as the dimensional approach lack an objective procedure for combining behaviour symptoms into a formal diagnosis that is appropriate both for boys and girls, irrespective of their age.

This study has two principal aims, one methodological and the other substantive. The first aim is to demonstrate the use of a statistical technique, latent class analysis, for diagnosing behaviour problems. Latent class analysis provide an empirical means of discerning how many diagnostic categories or classes are evident in a sample, based on the patterns of responses to several behaviour symptoms. In the case of physical aggression, for example, it determines whether children naturally cluster into two classes (e.g., aggressive and non-aggressive), or into three (e.g., aggressive, mildly aggressive and non-aggressive) or more classes. The technique also determines the probability than an individual belongs to each class, given his or her pattern of responses to the set of behaviour symptoms. Thus, it avoids the problem of setting arbitrary cutoff points for diagnosis. Also, because the technique can be applied separately for boys and girls, and for each age cohort, it allows for the possibility that the weight accorded to particular behaviour symptoms can vary, depending on the age and sex of the child. In demonstrating latent class analysis, we also note that the technique provides an objective means for assessing the relative importance of each behaviour symptom, enabling one to identify a small set of behaviour symptoms that could be used to make reliable diagnoses. The substantive aim of this study is to obtain estimates of the prevalence of physical aggression in the Canadian population, based on data from the National Longitudinal Study of Children and Youth. The analysis yields estimate of prevalence for boys and girls aged 2 through 11.

1.2 Latent Class Analysis as an Alternative Approach to Making a Formal Diagnosis

The issue of making a formal diagnosis on the basis of a list of behaviour symptoms can be addressed objectively within the framework of latent class analysis. Latent class analysis stems from Paul A. Lazarsfeld’s early work on latent structure analysis investigating the dependence of a set of manifest categorical variables on a small number of unobservable or latent variables (Lazarsfeld, 1950a, 1950b, 1954; Lazarsfeld & Henry, 1968). The work pioneered by Lazarsfeld has found a variety of applications in the educational, social and behavioural sciences (for reviews see Clogg, 1995; Langeheine, 1988). An area of special interest has been medical diagnosis, where latent class analysis has been used to obtain objective cutoff scores for psychiatric classification—case identification (Hudziak et al., 1998; Rindskopf & Rindskopf, 1986; Uebersax & Grove, 1990; Young, 1983).

Latent class analysis provides an empirical means to identify a set of mutually exclusive and exhaustive latent classes of individuals that account for the distribution of responses to a set of manifest discrete variables. The basic assumption of this model is that within any single latent class the manifest variables are independent of one another (i.e., the assumption of local independence). Thus, the association among the manifest variables results from the differences between the two or more latent classes. For example, the behaviour symptoms may be indicators of a latent variable, such as, physical aggression. Further, physical aggression may be comprised of two or more latent classes. On the one hand, there may be a latent class whose members do not tend to manifest the behaviour symptoms in question (i.e., low-aggressive). On the other hand, there may be a second latent class whose members tend to manifest the behaviour symptoms in question (i.e., high-aggressive). Each individual is assumed to be in one, and only one, of the latent classes. In essence, the population of interest is assumed to be made up of two (or more) qualitatively different types of children that may differ markedly in their propensity to manifest the behaviour symptoms in question.

The objective of latent class analysis is to reproduce the observed frequencies associated with the response patterns to the set of manifest variables using two kinds of parameters: (a) the probability that a randomly selected individual belongs to a given latent class, and (b) the conditional probability of a rating in a rating category for a particular behaviour symptom given the individual membership in a latent class. In the example given above, the outcome of a latent class analysis would comprise estimates of the proportion of children in the population who belong to the low- and high-aggressive latent classes. The outcome of the latent class analysis in this example would also comprise the estimates of the probability of manifesting each behaviour symptoms given membership in either the low- or the high-aggressive latent class.

The extent to which these parameters can be used to reproduce the response patterns to the set of manifest variables can be assessed empirically using either the Pearson chi-square statistic, X^2, or the likelihood-ratio chi-square statistic, L^2. Both the Pearson and the likelihood-ratio chi-square statistic have a large sample $\chi 2$ distribution under certain conditions (see Clogg, 1979). When the expected cell frequencies obtained under the latent class model are close to the observed cell frequencies, then the X^2 and/or L^2 value will be small and the model being examined can be said to provide an adequate fit to the data. A large value of X^2 and/or L^2, on the other hand, corresponds to a value in the right-hand tail of the $\chi 2$ distribution and is indicative of a poor fit of the model to the data. A standard by which to judge whether the X^2 and/or L^2 is large or small is given by the degrees of freedom. The degrees of freedom associated with the specified latent class model can be determined by subtracting the number of independent parameters to be estimated from the number of nonredundant observed cell frequencies. In the same vein, two hierarchically related latent class models (two latent class models are hierarchically related if one includes all the parameters of the other plus some additional ones) can be compared using the likelihood-ratio chi-square statistic since it can be partitioned exactly (Fienberg, 1980). That is, it is possible to subtract the L^2 of a latent class model based on the larger number of parameters (e.g., a three-class model) from the latent class model based on the smaller number of parameters (e.g., a two-class model). The degrees of freedom associated with the resultant L^2 are given by subtracting the degrees of freedom for the less restricted model from those for the more restricted model. A large difference in L^2, compared to the change in the degrees of freedom, suggests that the added parameters of the less restricted model have real significance. On the other hand, a drop in L^2 from the more restricted model to the less restricted model close to the change in number of degrees of freedom indicates that there is no significant improvement in fit when the less restricted latent class model is chosen to represent the data. Thus, unlike the conventional approach latent class analysis offers a systematic approach to test for the existence of two or more qualitatively different types of individuals in the population of interest. That is, it provides the means for deciding on an appropriate number of latent classes on the basis of the available data.

Once we have obtained parameter estimates for a particular latent class model prediction can be made concerning latent class membership for each individual based on his or her observed pattern of responses to the set of manifest variables. One assignment rule would be to assign each individual to the latent class t (t = 1, 2, ...T) which maximizes the probability of observing his or her response pattern to the set of manifest variables. In the example given above, an individual with a given response vector would be classified as low-aggressive if his or her posterior conditional probability of membership in this latent class is higher than his or her posterior conditional probability of membership in the other latent class; otherwise, he or she would be classified as high-aggressive. Hence, unlike the conventional approach, the latent class classification scheme is not based on an arbitrary cutoff point but rather on an optimal classification rule that insures that the expected (i.e., theoretical) proportion of misclassified individuals is minimized.

Only rarely will a symptom be perfectly sensitive (i.e., the symptom is always present among individuals who are disordered), and therefore, a symptom often presents a false-negative rate above 0. Similarly, rarely will a symptom be perfectly specific (i.e., the symptom is never present among individuals who are nondisordered), and therefore, a symptom often presents a false-positive rate above 0. Generally speaking, a symptom gives valuable but not perfect diagnostic information as to the true disorder state of the individual. Consider the situation where a cutoff point has been chosen which is intended to distinguish between two disorder states; namely, disorder present or absent. The symptom may sometimes indicate the disorder when, in fact, the individual does not have the disorder and/or it may sometimes fail to identify the disorder when it is present. As a result, it is impossible to define a cutoff point that distinguishes perfectly all those with a disorder from all those without it, and therefore, any classification rule will yield some misclassifications. Epidemiologists distinguish between the predictive value positive and the predictive value negative of a test (Galen & Gambino, 1975; Weinstein et al, 1993). In the case of two disorder states the predictive value positive of the test is the posterior conditional probability of having the disorder given a positive test result. Conversely, the predictive value negative of the test is the posterior conditional probability of not having the disorder given a negative test result. Epidemiologists also define the diagnostic information the test conveys as the ratio of the conditional probability of having the disorder given a positive test result to the conditional probability of not having the disorder given a positive test. To the extent that a test result conveys diagnostic information it can be used effectively to revise our prior probability that an individual does or does not have the disorder—the prior probability is equal to the prevalence of the disease in the population. Within the latent class framework the predictive value positive and the predictive value negative of the symptoms that are used simultaneously to predict latent class membership can be defined for each latent class. The predictive value positive can be defined as the posterior conditional probability of membership in a particular latent class for the individuals who are predicted to belong to this latent class. In contrast, the predictive value negative can be defined as the posterior conditional probability of nonmembership in a particular latent class for the individuals who are not predicted to belong to this latent class. In addition, the diagnostic information provided by the symptoms can be defined for any given latent class as the ratio of the posterior conditional probability of membership in this latent class to the posterior conditional probability of membership in the other latent classes for the individuals who are predicted to belong to this latent class. Hence, unlike the conventional approach, the latent class approach provides a framework to optimize the diagnostic choices—the trade-off between false positives and false negatives—given the inherent uncertainty attached to the process of making a formal diagnosis (i.e., a child's diagnosis can only be arrived at in a probabilistic manner). Further, this optimal trade-off between false-positive rates and false-negative rates can be arrived at while taking into account the consequences of misclassifications (i.e., minimize the negative consequences of misclassifications and/or maximize the positive consequences of correct classification).

Another advantage of latent class analysis is that it can include information about categorical concomitant variables (i.e., variables like sex or age that can be used to group individuals) (Clogg & Goodman, 1984, 1985, 1986; Dayton & Macready, 1988). Simultaneous latent class analysis across several groups can be used to test whether the proportion of individuals in each latent class vary from one level of the covariate to another. This can be accomplished by imposing inter-group homogeneity constraints on the estimated latent class proportions. In the example given above, simultaneous latent class analysis could be used to test whether the prevalence of physical aggression is the same for boys and girls. In the case where the increase in L^2 is small compared to the increase in the degrees of freedom this would suggest that two randomly selected individuals from the two groups have the same probability to belong to the low- and high-aggressive latent classes. Hence, unlike the conventional approach, the multi-group latent class analysis provides the means to compare the prevalence estimates across groups of individuals without having to assume that the propensity to manifest the behaviour symptoms are the same across groups (i.e., it allows for differential conditional behaviour symptom rating probabilities for individuals within a given latent class who are at specified level of the covariate).

2. Method

2.1 The National Longitudinal Survey of Children and Youth

The National Longitudinal Survey of Children and Youth (NLSCY) is the first nation-wide household survey on child health in Canada. It has been developed conjointly by Human Resources Development Canada and Statistics Canada. For the first data collection cycle (i.e., 1994-95) a representative sample of approximately 25,000 children, ranging in age from new-born to 11 years was surveyed. It includes about 2,000 children per age group, half boys and half girls, from 2 to 11 years of age. Most of these children are being followed longitudinally, with additional data collected every two years. The survey instruments include a number of questions assessing various behavioural and emotional problems such as anxiety, hyperactivity, inattention and physical aggression. The primary respondent was the person most knowledgeable about the child, which in the majority of cases was the mother. Other informants included the child himself or herself and the child’s teacher but the information collected from these two informants was not available at the time of producing this report. This survey provides a unique opportunity to obtain both cross-sectional and longitudinal estimates of the prevalence of physical aggression in the Canadian population of children from early childhood to adolescence. For the first cycle of data collection the survey can yield cross-sectional estimates of the prevalence of physical aggression for 2 to 11 year-old children.

2.2 Subjects

For the first NLSCY cycle (1994-1995), physical aggression was assessed for children from 2 to 11 years of age. The distribution of children by sex and age is presented in Table 1.

2.2.1 Cases with missing values

We eliminated cases with missing values on any of the three behaviour symptoms used to assess physical aggression (see below). Not too many cases were eliminated for that reason, however. For 2- to 11-year-old boys only 2%, .1% and .1% had missing values on three, two or one of the three behaviour symptoms, respectively. Similarly, for 2- to 11-year-old girls only 1.6%, .07% and 4% had missing values on three, two or one of the three behaviour symptoms, respectively. We assumed that data were missing at random.

Table 1

The Distribution of Children by Sex and Age for the First Collection Cycle (1994-1995) of the National Longitudinal Survey of Children and Youth

Age (years)	Sex	
	Boy	Girl
2	1,000 (938)	963 (925)
3	1,018 (981)	928 (900)
4	968 (947)	966 (955)
5	916 (889)	878 (858)
6	951 (931)	850 (828)
7	857 (839)	892 (877)
8	893 (876)	887 (873)
9	896 (878)	838 (820)
10	904 (895)	863 (853)
11	845 (837)	822 (815)

Note: Numbers in parentheses refer to cases with no missing value on any of the three behaviour symptoms used to assess physical aggression.

2.2.2 Sampling plan and weights

In a probability sample such as the NLSCY, each case is assigned a weight that stands for the number of individuals in the population that this person "represents." These weights were used here to produce unbiased estimate of the prevalence of physical aggression in the Canadian population of children and adolescents. Whenever the statistical analyses were performed on the data from a particular subgroup (e.g., 2-year-old girls) each weight was divided by the mean of the weights for the subgroup in question to get appropriate statistical tests.

2.3 Instruments

Many behaviour symptoms have been included in the NLSCY that may be used to assess children's physical aggression, namely: (a) Gets into many fights? (*abecq6g*); (b) When another child accidentally hurts him/her (such as bumping into him/her), assumes that the other child meant to do it, and then reacts with anger and fighting? (*abecq6x*); (c) Physically attacks people? (*abecq6aa*); (d) Threatens people? (*abecq6ff*); (e) Is cruel, bullies or is mean to others? (*abecq6jj*); and (f) Kicks, bites, hits other children? (*abecq6nn*). Each behaviour symptom was rated by the PMK using a three-point Likert scale: never or not true, sometimes or somewhat true, and often or very true. These were scored 1, 2 and 3, respectively.

For the purpose of conducting the latent class analysis we chose the three behaviour symptoms that seemed to best correspond to the domain of behaviours to be assessed (i.e., physical aggression). This was done in an attempt to avoid large sparse multidimensional tables that may wreak havoc with the asymptotic suitability of the $\chi 2$ distribution for the Pearson and the likelihood-ratio chi-square statistics (see Fienberg, 1980). This is a particular concern in our analysis because the third rating category is generally endorsed by less than 6 per cent of the PMKs. For the 4-11 year-old children the following three behaviour symptoms pertaining to physical aggression were chosen: (a) Gets into many fights? (*abecq6g*); (b) Physically attacks people? (*abecq6aa*); and (c) Kicks, bites, hits other children? (*abecq6nn*). Because the behaviour symptom “Physically attacks people?” (*abecq6aa*) was not included for 2-3 year-old children we have used the only behaviour symptom available for these two age groups, namely, “When another child accidentally hurts him/her (such as bumping into him/her), assumes that the other child meant to do it, and then reacts with anger and fighting?” (*abecq6x*). Note that the behaviour symptoms “Threatens people?” (*abecq6ff*) and “Is cruel, bullies or is mean to others?” (*abecq6jj*) refer to behaviours that are not clearly physically aggressive behaviours. Children could be considered cruel or mean and threatening without being *physically* cruel, mean and threatening.

2.4 Statistical Method

One particular application of latent class analysis has been the scaling of response patterns (Clogg, 1988; Clogg & Sawyer, 1981; Dayton & Macready, 1980; Goodman, 1975). This approach is used here to examine the extent to which the three behaviour symptoms elicit PMKs' ratings in the same rating category for a given child. With three trichotomous behaviour symptoms ($\underline{n} = 3$) there are 3n possible response patterns ($3^3 = 27$). Under a model which assumes perfect agreement on all three behaviour symptoms, however, only 3 of these patterns will occur: (1, 1, 1), (2, 2, 2), and (3, 3, 3). This "latent agreement" model can be represented as a *restricted three-class model*. As its name suggests, this model comprises three latent classes: (a) a *low-aggressive* latent class which members are rated in rating category 1 (i.e., never or not true) on all three behaviour symptoms, (b) a *medium-aggressive* latent class which members are rated in rating category 2 (i.e., sometimes or somewhat true) on all three behaviour symptoms, and (c) a *high-aggressive* latent class which members are rated in rating category 3 (i.e., often or very true) on all three behaviour symptoms. Note that under this restricted three-class model a child's level of physical aggression is perfectly reflected in his or her observed response pattern.

However, the three behaviour symptoms may not always elicit ratings in the same rating category. A latent class model that accounts for the lack of agreement on the three behaviour symptoms is the *unrestricted three-class model*. This model allows for the fact that members of, say, the low-aggressive latent class, may receive ratings in a rating category other than 1. In other words, a rating in the other two response categories is allowed for members of the low-aggressive latent class. Ideally, a rating in rating category 2 or 3 should be a relatively rare occurrence for members of the low-aggressive latent class. Since there are no restrictions on either the latent class probabilities or the conditional behaviour symptom rating probabilities, 20 parameters must be estimated under this model. There are 18 conditional behaviour symptom rating probabilities (i.e., two for each behaviour symptom since they must sum to 1 within each latent class) and 2 unique latent class probabilities in the population since they must sum to 1. Hence, the degrees of freedom for the unrestricted three-class model are (27 - 1 - 20) = 6.

Maximum likelihood parameter estimates for the various latent class models considered here were all obtained from a general computer program for maximum-likelihood latent-structure analysis (MLLSA) written by the late Professor Clifford C. Clogg (1977) (see McCutcheon 1987). This program is included in a statistical package for categorical data analysis (CDAS) which is distributed freely by Scott R. Eliason. For the purpose of this report we used the pre-release command line version of MLLSA for CDAS, version 4.0, for OS/2 (Eliason, 1997).

3. Results

3.1 Reliability Estimates

Within classical true-score theory a test's reliability can be defined as the squared correlation between observed and true scores which is the ratio of true-score variance to observed-score variance (Allen & Yen, 1979). Defined this way a test's reliability is equivalent to the *coefficient of determination* in structural equation modeling which is equal to 1 minus the ratio of the determinant of the error-score variance to the determinant of the observed-score variance (Bollen, 1989). The coefficient of determination estimates obtained from a one-common factor model are presented in Table 2. These estimates are remarkably high; they vary from .85 at 3 years of age to .99 at 10 years of age for boys and from .78 at 3 years of age to .95 at 10 years of age for girls. These results suggest that the error-score variance is small relative to the observed-score variance in the physical aggression data.

Table 2

Reliability of the Three Behaviour Symptoms Used to Assess Physical Aggression

Age (years)	Reliability estimate	
	Boy	Girl
2	.874	.841
3	.850	.775
4	.881	.842
5	.994	.893
6	.876	.900
7	.865	.882
8	.925	.882
9	.895	.884
10	.999	.947
11	.880	.935

Note: Reliability estimates derived from a one-common factor model using a generally weighted least squares method of estimation (Jöreskog & Sörbom, 1993).

3.2 Choosing an Appropriate Latent Class Model for the Physical Aggression Data

Before we can estimate the prevalence of physical aggression in the Canadian population of children aged 2 to 11 years we have to determine whether we can account for the physical aggression data by postulating the existence of two or more mutually exclusive and exhaustive latent classes of children in the Canadian population. The goodness-of-fit statistics for the various latent class models considered here are presented in Table 3.

First, we considered the model of mutual independence among the behaviour symptoms, the unrestricted one-class model. Within that single latent class, the rating for any one behaviour symptom is assumed to be independent of the rating of the other two behaviour symptoms. The value of the likelihood-ratio chi-square (L^2) associated with the unrestricted one-class model for 2-year-old children is 427.07 and 315.69 with 20 degrees of freedom, for boys ($p < .00$) and girls ($p < .00$), respectively. Moreover, not surprisingly, this model does not afford an acceptable fit to the physical aggression data for the other age groups as well (see Table 3). This confirms that the ratings are not statistically independent; and therefore, latent class models that assume two or more latent classes are of interest.

Second, we considered the unrestricted two-class model (Bergan, 1983; Dayton & Macready, 1976; Macready & Dayton, 1977; Rindskopf, 1983). This model assumes that the PMKs' ratings on the behaviour symptoms can be explained by a single latent variable made up of two mutually exclusive and exhaustive latent classes of children, a low- and a high-aggressive latent class, respectively. Children in the low-aggressive class would tend *not* to manifest the behaviour symptoms in question, whereas children in the high-aggressive class would tend to manifest the behaviour symptoms in question. Hence, like the conventional approach to making a formal diagnosis, this model assumes that the childhood disorder, namely, physical aggression, is either present or absent and that no other types of individuals exist in the population. The value of the L^2 associated with the unrestricted two-class model for 2-year-old boys is 63.50 with 14 degrees of freedom ($p < .00$). Hence, the unrestricted two-class model does not seem to provide a good fit to the physical aggression data for 2-year-old boys. Similarly, this model yields a L^2 of 64.80 with 13 degrees of freedom ($p < .00$) for two-year-old girls. Furthermore, we have obtained very

Table 3

Pearson and Likelihood-ratio Chi-Square Statistics for Some Latent Class models for Physical Agression

Model	Pearson chi-square (X^2)		Likelihood-ratio chi-square (L^2)		Degrees of freedom		p[a]		% of variance		% correctly allocated	
	M	F	M	F	M	F	M	F	M	F	M	F
	2-year-old											
Independence	1,399.27	1,807.84	427.07	315.69	20	20	.00	.00				
Unrestricted two-class	116.64	134.49	63.50	64.80	14b	13	.00	.00	85.13	79.48	91.70	93.81
Unrestricted three-class	7.70	10.29	8.38	10.93	7c	8c	.30	.21	98.04	96.54	88.78	91.37
	3-year-old											
Independence	1,180.66	1,456.27	520.06	338.23	20	20	.00	.00				
Unrestricted two-class	80.22	153.77	68.07	40.90	14b	14b	.00	.00	86.91	87.91	96.20	90.76
Unrestricted three-class	9.40	9.09	13.01	8.33	8c	6	.11	.22	97.50	97.54	88.83	90.14
	4-year-old											
Independence	1,534.00	6,038.16	582.17	384.92	20	20	.00	.00				
Unrestricted two-class	96.03	309.70	51.97	49.90	14b	14b	.00	.00	91.07	87.04	95.89	94.08
Unrestricted three-class	9.02	8.11	10.14	10.68	9c	10c	.34	.38	98.26	97.23	94.70	93.69
	5-year-old											
Independence	1,080.67	7,188.99	459.38	273.46	20	20	.00	.00				
Unrestricted two-class	75.41	412.19	50.47	9.62	14b	15b	.00	.84	89.01	96.48	95.26	94.53
Unrestricted three-class	11.58	1.32	13.7	1.54	9c	12c	.13	1.0	97.02	99.44	95.31	94.26
	6-year-old											
Independence	2,373.66	13,543.70	463.58	368.40	20	20	.00	.00				
Unrestricted two-class	105.45	374.98	68.34	41.75	15b	15b	.00	.00	85.26	88.67	95.68	96.46
Unrestricted three-class	41.34	16.09	35.88	16.75	9c	11c	.00	.12	92.26	95.45	94.67	96.37
	7-year-old											
Independence	910.50	5,527.58	369.84	256.73	20	20	.00	.00				
Unrestricted two-class	37.79	97.43	32.79	14.86	14b	15b	.00	.46	91.13	94.21	95.16	96.64
Unrestricted three-class	18.64	5.13	15.89	7.66	9c	14c	.07	.91	95.70	97.02	94.06	96.45
	8-year-old											
Independence	1,275.93	816.65	537.84	286.74	20	20	.00	.00				
Unrestricted two-class	39.40	20.60	34.45	22.79	15b	14b	.00	.11	93.59	92.05	96.69	97.29
Unrestricted three-class	5.87	10.74	8.59	12.88	9c	10c	.48	.23	98.40	95.51	94.00	97.11

Table 3 (Continued)

Pearson and Likelihood-ratio Chi-Square Statistics for Some Latent Class models for Physical Agression

	9-year-old											
Independence	3,897.88	939.78	442.04	212.21	20	20	.00	.00				
Unrestricted two-class	148.79	132.35	46.02	16.97	15b	15b	.00	.32	89.59	92.00	95.60	97.17
Unrestricted three-class	6.14	4.66	8.23	4.50	9c	13c	.51	.99	98.14	97.88	94.88	97.28
	10-year-old											
Independence	1,948.50	13,799.73	382.39	382.8	20	20	.00	.00				
Unrestricted two-class	64.05	172.52	37.93	45.69	15b	15b	.00	.00	90.08	88.06	96.86	98.17
Unrestricted three-class	7.68	4.96	10.00	5.16	10c	12c	.44	.95	97.39	98.65	96.76	97.99
	11-year-old											
Independence	4,556.44	7,275.56	344.19	200.74	20	20	.00	.00				
Unrestricted two-class	166.86	180.31	52.48	15.35	14b	14b	.00	.35	84.75	92.35	95.67	97.24
Unrestricted three-class	4.57	7.23	5.14	4.47	11c	12d	.92	.97	98.51	97.77	94.32	97.04

Note: [a] Significance level associated with the likelihood-ratio chi-square statistic.

[b] Strictly speaking there are 13 degrees of freedom for this model, but a terminal solution was obtained in which one or more conditional behaviour symptom rating probabilities converged to either 0 or 1. Therefore, a new solution was estimated in which these parameters were set a priori equal to that value. This procedure is described and utilized in Clogg (1979) and Goodman (1974a, 1974b). This allows us to assume that L^2 has nonetheless a large sample $\chi 2$ distribution (i.e., L^2 is asymptotically distributed as chi-square).

[c] Strictly speaking there are 6 degrees of freedom for this model, but a terminal solution was obtained in which one or more conditional behaviour symptom rating probabilities converged to either 0 or 1. Therefore, a new solution was estimated in which these parameters were set a priori to that value (see justification above).

[d] For one reason or another the unrestricted three-class model was empirically underidentified for 11-year-old girls; and therefore, restrictions were imposed on the conditional behaviour symptom rating probabilities such that $\pi_{j(1)|1} = \pi_{j(3)|3}$, $\pi_{j(2)|1} = \pi_{j(2)|3}$ and $\pi_{j(3)|1} = \pi_{j(1)|3}$.

similar results for the other age groups (see Table 3). Hence, the hypothesis that there may be only two exclusive and exhaustive latent classes of children in the Canadian population was rejected for all the age groups except for 8-year-old girls for whom the unrestricted two-class model seems to provide an acceptable fit to the physical aggression data according to both the Pearson and the likelihood-ratio chi-square statistics. These results seem to suggest that there are substantial inter-individual differences within the two categories— potentially useful information—that needs to be considered in order to identify homogeneous groups of children in the population.

These results led us to consider a latent class model that includes three exclusive and exhaustive latent classes of children, namely, the unrestricted three-class model described above. This model yields a L^2 of 8.38 with 7 degrees of freedom for 2-year-old boys ($p < .30$). Hence, the unrestricted three-class model seems to fit the physical aggression data for 2-year-old boys remarkably well. Similarly, this model yields a L^2 of 10.93 with 8 degrees of freedom ($p < .21$) for 2-year-old girls. Furthermore, the unrestricted three-class model seems to provide an excellent fit to the physical aggression data for the other age groups except for 6-year-old boys where the model is rejected (see Table 3).

Another way to evaluate the fit of the unrestricted three-class model to the physical aggression data is to compare it to the model of mutual independence since these two models are hierarchically related. We found that by postulating the existence of three mutually exclusive and exhaustive latent classes of children we could account for a great deal of the variance in the PMKs' ratings on the physical aggression behaviour symptoms; that is, 98 per cent [1 - (8.38 / 427.07) = .98] and 97 per cent [1 - (10.93/315.69) = .97] for 2-year-old boys and 2-year-old girls, respectively. Furthermore, we obtained very similar results for the other age groups (see Table 2); the unrestricted three-class model generally accounting for well over 90 per cent of the variance in the physical aggression data. Hence, on both accounts the unrestricted three-class model seems to provide an excellent fit to the physical aggression data; hence, by allowing for three homogeneous groups of children in the population we could account for the physical aggression data. And, therefore, even if it were possible to include an additional latent class to the model it would not significantly improve the fit of the model to the physical aggression data except for 6-year old boys.[1] Of course, if the three behaviour symptoms had been rated by the PMKs using a different Likert scale or if more than three behaviour symptoms had been used to assess physical aggression or if other behaviour symptoms had been used to assess physical aggression we may have obtained different results. No matter how interesting these questions may be they can not be answered using the physical aggression data from the NLSCY.

Table 4 contains the parameter estimates under the unrestricted three-class model. Figure 1, 2 and 3 display the estimates of the conditional behaviour symptom rating probabilities for two-year-old boys while Figure 4, 5 and 6 display the same estimates for two-year-old girls.

Inspection of the estimates of the conditional behaviour symptom rating probabilities, πj(k)|t, reveals a clear ordering among the three latent classes. *First, the odds of being rated in rating category 1 (i.e., never or not true) tend to be much higher for children who are members of the first latent class than for those who belong to the second latent class. And, in turn, the odds of being rated in rating category 1 tend to be much higher for those who belong to the second latent class than for those who belong to the third latent class.* Consider the odds of being rated in rating category 1 on the first behaviour symptom (i.e., Gets into many fights? —*abecq6g*) for boys. For instance, at two years of age, the odds were .94 to .06; that is, (.94 / .06) = 14.60 for boys who are members of the first latent class (see Table 3). Comparatively, the odds were only (.24 / .76) = .31 and (.08 / .92) = .08 for those who are members of the second and third latent class, respectively (see Table 3). Hence, the odds of being rated in rating category 1 were (14.60 / .31) = 46.62 times higher for 2-year-old boys who are members of the first latent class than for those who are members of second latent class. Similarly, the odds of being rated in rating category 1 were (.31 / .08) = 3.81 times higher for 2-year-old boys who are members of the second latent class than for those who are members of the third latent class. *Second, the odds of being rated in rating category 2 (i.e., sometimes or somewhat true) tend to be much higher for children who are members of the second latent class than for those who belong to either the first or the third latent class.* Consider the odds of being rated in rating category 2 on the first

[1] Note that with only three trichotomous behaviour symptoms a four-class model is not identifiable (for more details on latent class model identifiability see McCutcheon, 1987).

Table 4

Parameter Estimates Under the Unrestricted Three-class Model for Physical Aggression
Latent class ($\underline{t}$ = 1, 2, 3)

	Low-aggressive ($\underline{t}$ = 1) Age (years)										**Medium-aggressive ($\underline{t}$ = 2)** Age (years)										**High-aggressive ($\underline{t}$ = 3)** Age (years)							
Boys																												
	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9
π_t	.62	.69	.73	.77		.79	.77	.78	.82	.81	.34	.21	.24	.17		.18	.16	.20	.17	.17	.04	.10	.03	.06		.03	.06	.02
$\pi_{A(1)\|t}$	.94	.82	.76	.75		.76	.76	.78	.75	.78	.24	.13	.20	.07		.10	.07	.14	.24	.20	.08	.01	.07	.29		.00	.18	.02
$\pi_{A(2)\|t}$	.06	.16	.24	.23		.21	.23	.22	.23	.20	.72	.87	.67	.93		.82	.90	.76	.58	.68	.34	.42	.40	.00		.01	.30	.18
$\pi_{A(3)\|t}$	.00	.02	.01	.02		.03	.01	.00	.02	.02	.04	.01	.13	.00		.08	.04	.11	.18	.12	.59	.57	.53	.71		.99	.52	.80
$\pi_{B(1)\|t}$	.87	.73	.96	.97		.95	.99	.93	.98	.96	.38	.25	.14	.20		.21	.20	.30	.11	.31	.13	.22	.00	.00		.09	.15	.26
$\pi_{B(2)\|t}$	.13	.25	.03	.03		.05	.01	.07	.02	.04	.50	.64	.86	.77		.77	.75	.67	.89	.69	.20	.22	.33	.81		.68	.54	.07
$\pi_{B(3)\|t}$	.00	.02	.01	.00		.00	.00	.00	.00	.00	.11	.11	.00	.02		.01	.04	.02	.00	.00	.67	.56	.67	.19		.23	.32	.67
$\pi_{C(1)\|t}$	.77	.87	.92	.91		.91	.94	.98	.95	.97	.27	.22	.25	.23		.39	.39	.31	.44	.44	.00	.00	.10	.44		.00	.00	.00
$\pi_{C(2)\|t}$	.23	.13	.08	.08		.09	.06	.02	.05	.03	.69	.78	.74	.77		.54	.59	.66	.54	.56	.33	.71	.44	.45		.86	.90	.37
$\pi_{C(3)\|t}$	.00	.00	.00	.01		.00	.00	.00	.00	.00	.04	.00	.01	.00		.08	.03	.03	.03	.00	.67	.29	.46	.11		.14	.10	.63
Girls																												
	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9
π_t	.77	.65	.77	.81	.84	.87	.87	.90	.89	.90	.20	.34	.22	.19	.15	.12	.12	.10	.10	.10	.02	.01	.01	.00	.00	.00	.01	.00
$\pi_{A(1)\|t}$	.85	.86	.77	.83	.86	.79	.77	.82	.76	.76	.19	.20	.16	.20	.06	.24	.21	.15	.12	.18	.00	.05	.00	.00	.18	.00	.23	.76
$\pi_{A(2)\|t}$	.14	.13	.22	.15	.13	.20	.21	.16	.23	.21	.76	.77	.74	.72	.74	.62	.67	.74	.67	.62	.29	.23	.00	.00	.00	.00	.37	.00
$\pi_{A(3)\|t}$	.00	.00	.01	.02	.01	.01	.02	.02	.01	.03	.04	.03	.10	.08	.20	.14	.13	.11	.21	.20	.71	.72	1.0	1.0	.82	1.0	.41	.24
$\pi_{B(1)\|t}$	.82	.78	.96	.98	.99	.99	.98	.98	.98	.99	.40	.26	.40	.43	.47	.38	.25	.27	.23	.28	.04	.14	.00	.00	.18	.00	.19	.00
$\pi_{B(2)\|t}$	.14	.21	.04	.02	.01	.01	.01	.02	.01	.01	.54	.57	.58	.57	.54	.57	.75	.73	.77	.71	.13	.12	.34	.44	.18	.00	.00	.39
$\pi_{B(3)\|t}$	.03	.01	.00	.00	.00	.00	.01	.00	.00	.00	.06	.17	.02	.00	.00	.04	.00	.00	.00	.01	.83	.74	.66	.56	.64	1.0	.81	.61
$\pi_{C(1)\|t}$	.81	.89	.92	.96	.96	.97	.99	.97	.99	.98	.13	.33	.25	.39	.35	.28	.42	.44	.35	.46	.00	.02	.00	.00	.00	.00	.00	.00
$\pi_{C(2)\|t}$	.19	.10	.08	.04	.04	.03	.01	.03	.01	.02	.84	.67	.74	.60	.65	.72	.53	.56	.63	.54	.38	.17	.15	.41	.01	.25	.95	.51
$\pi_{C(3)\|t}$	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.01	.00	.00	.00	.05	.00	.02	.00	.62	.81	.85	.59	.99	.75	.05	.49

Note: Behaviour symptom A and C refer to the first (i.e., Gets into many fights?—*abecq6g*) and third (i.e, Kicks, bites, hits other children?—*abecq6nn*) behaviour symptom, respectively. Behaviour symptom B refers to the second behaviour symptom (i.e, Recats with anger and fighting?—*abecq6x*—for 2-3 year-old children and Physically attacks people—*abecq6aa*—for 4-11 year-old children). π_t refers to the probability of being a member of the $\underline{t}$-th latent class ($\underline{t}$ = 1, 2, 3). $\pi_{j(k)|t}$ refers to the probability of a rating in category $\underline{k}$ ($\underline{k}$ = 1, 2, 3) to behaviour symptom $\underline{j}$ (j = A, B, C) given membership in latent class $\underline{t}$ ($\underline{t}$ = 1, 2, 3). The latent class model reported here for the 11-year-old girls is a restricted three-class model wherein some restrictions were imposed on the conditional behaviour symptom rating probabilities such that $\pi_{j(1)|1} = \pi_{j(3)|3}$, $\pi_{j(2)|1} = \pi_{j(2)|3}$ and $\pi_{j(3)|1} = \pi_{j(1)|3}$. The unrestricted three-class model did not fit the physical aggression data for 6-year-old boys.

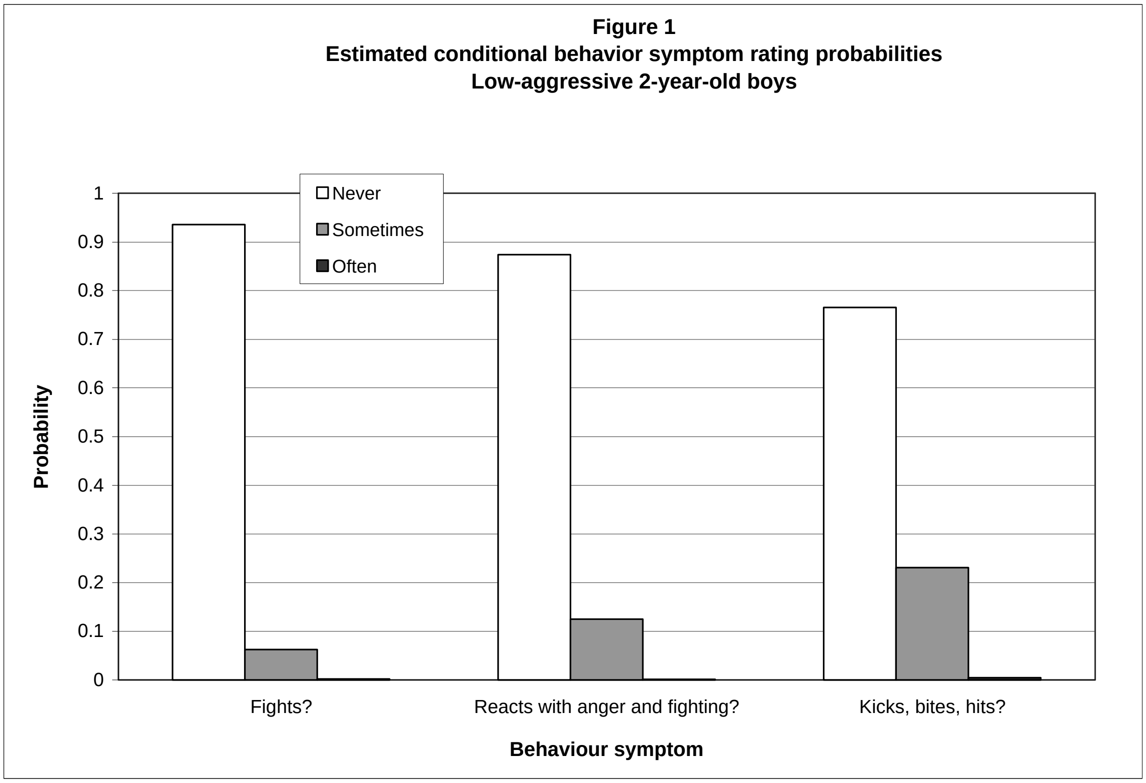


Figure 1
Estimated conditional behavior symptom rating probabilities
Low-aggressive 2-year-old boys
Never
Sometimes
Often
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fights?
Reacts with anger and fighting?
Kicks, bites, hits?
Behaviour symptom

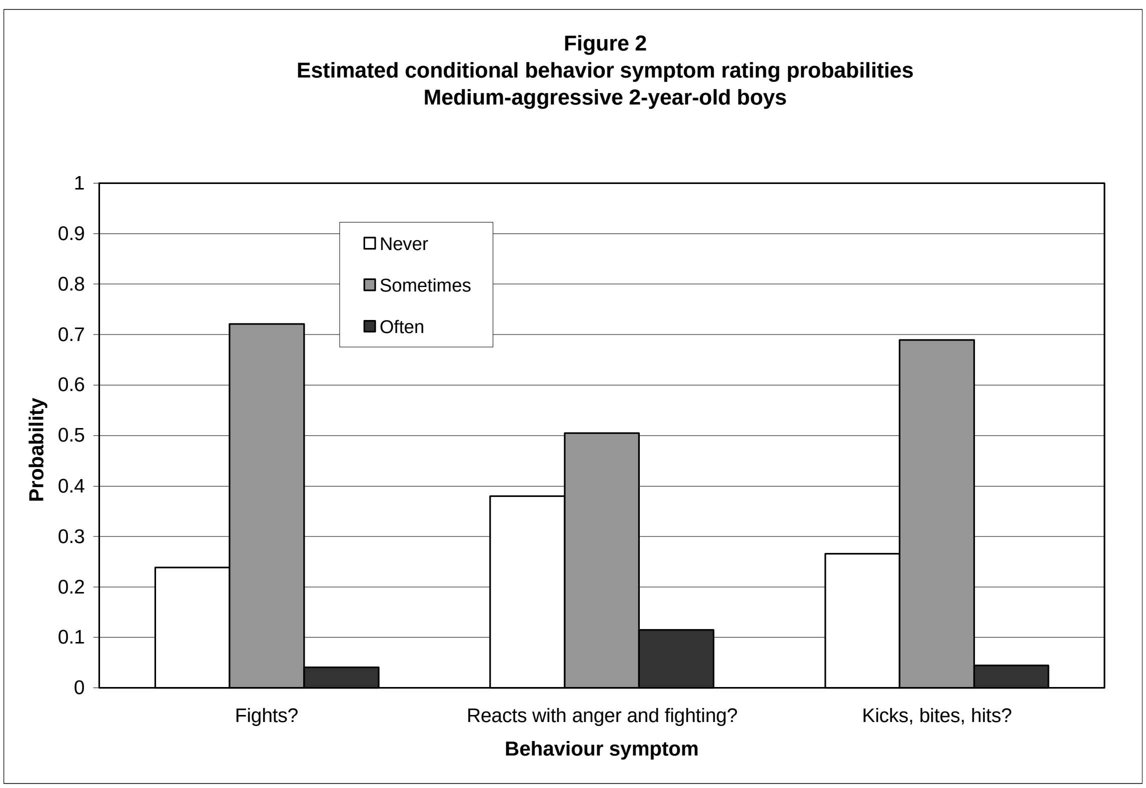


Figure 2
Estimated conditional behavior symptom rating probabilities
Medium-aggressive 2-year-old boys
Never
Sometimes
Often
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fights?
Reacts with anger and fighting?
Kicks, bites, hits?
Behaviour symptom

Figure 3
Estimated conditional behavior symptom rating probabilities
High-aggressive 2-year-old boys

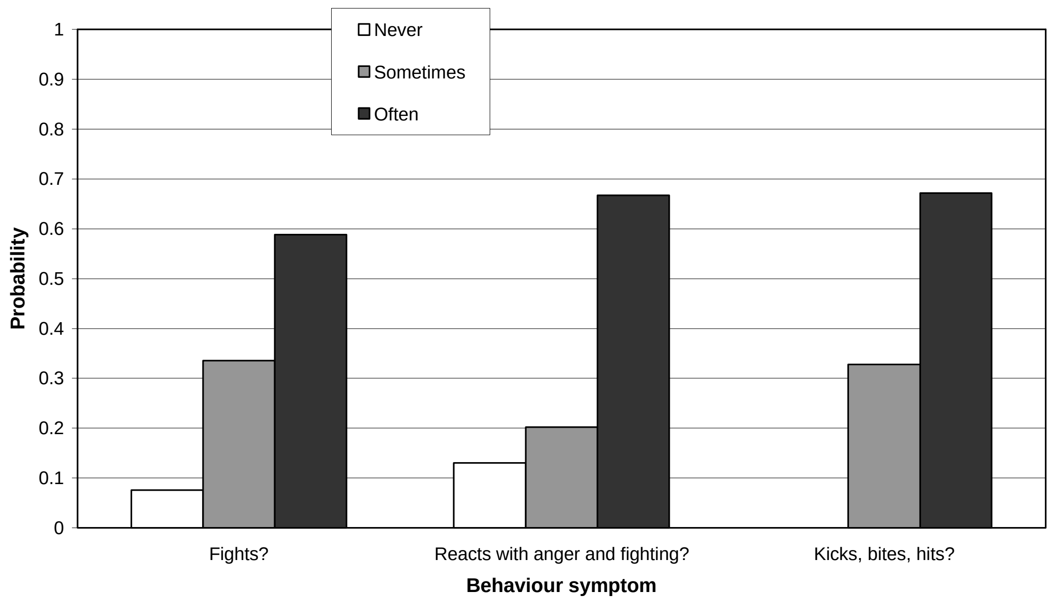


Figure 4
Estimated conditional behavior symptom rating probabilities
Low-aggressive 2-year-old girls

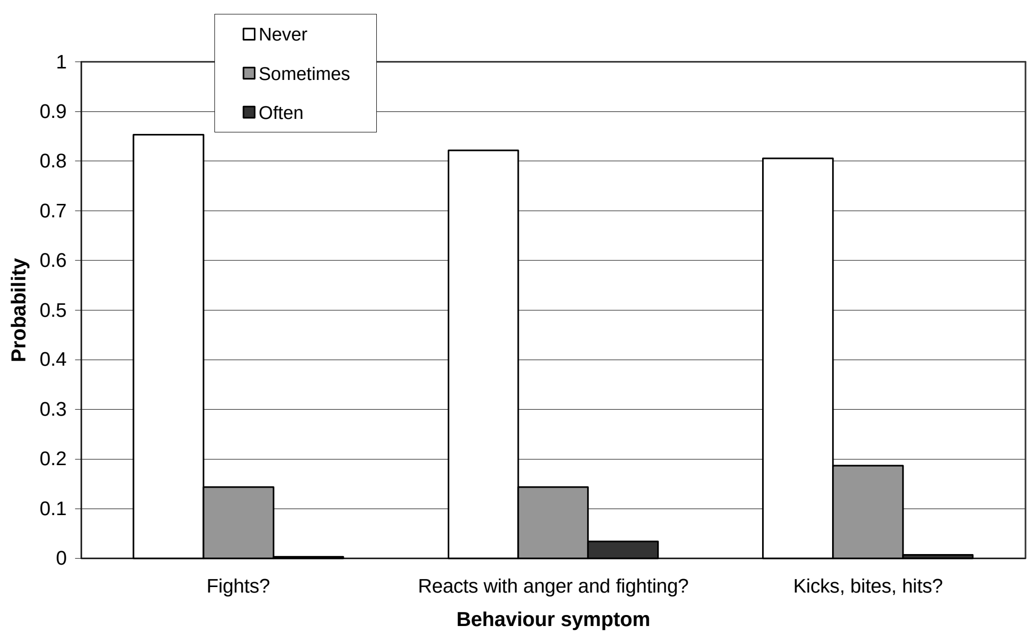


Figure 5
Estimated conditional behavior symptom rating probabilities
Medium-aggressive 2-year-old girls

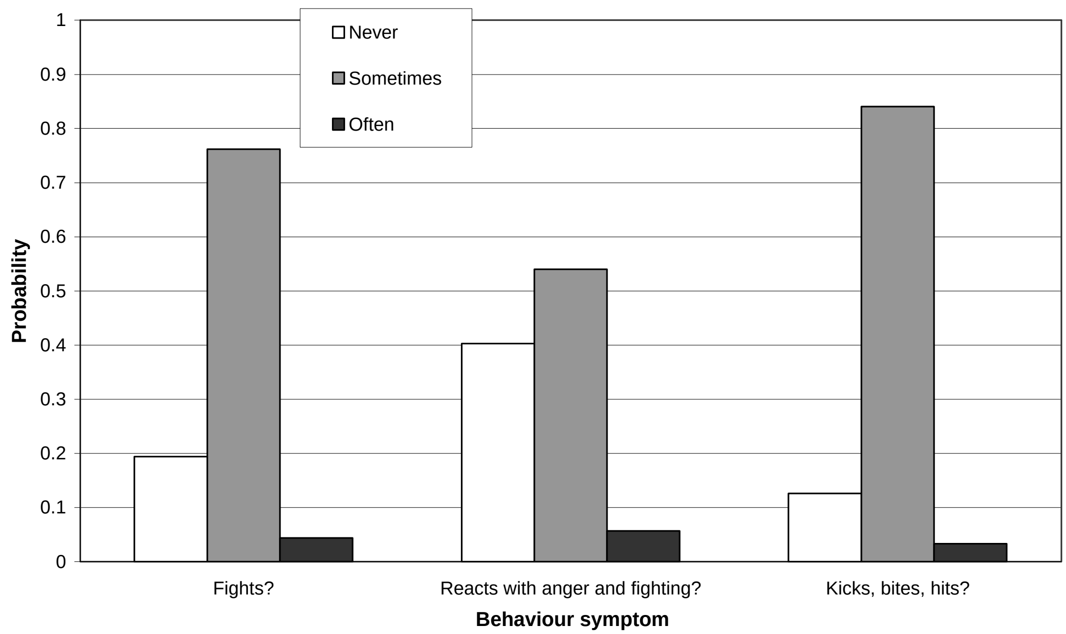
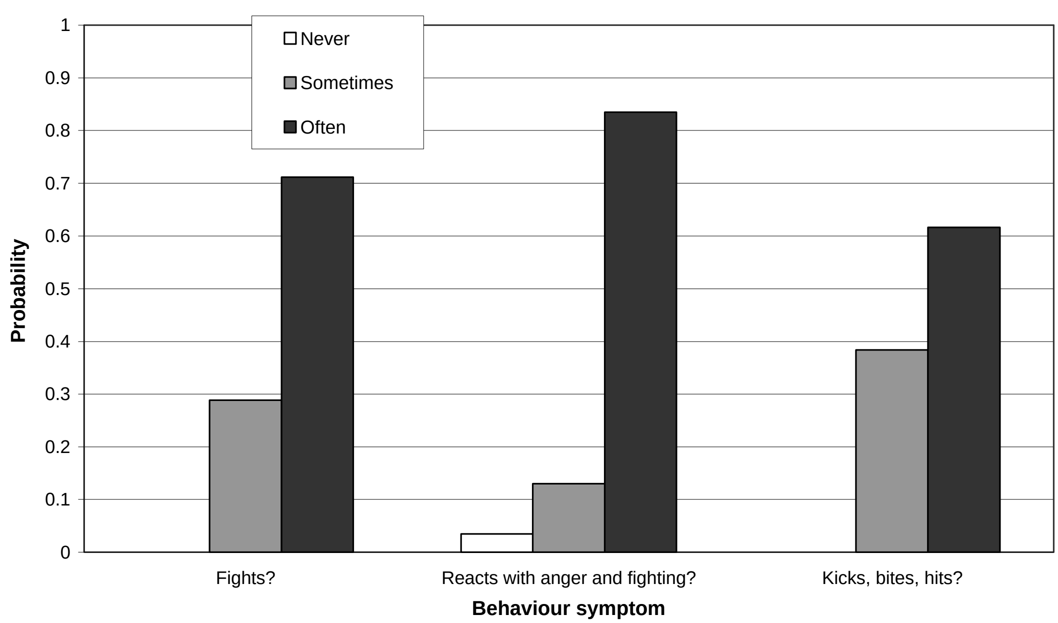


Figure 6
Estimated conditional behavior symptom rating probabilities
High-aggressive 2-year-old girls



behaviour symptom (i.e., Gets into many fights?—*abecq6g*) for boys. For instance, at two years of age, the odds were (.72 / .28) = 2.58 for those who are members of the second latent class (see Table 3). Comparatively, the odds were only (.06 / .94) = .07 and (.34 / .66) = .51 for those who are members of the first and third latent class, respectively (see Table 3). Hence the odds of being rated in rating category 2 were (2.58 / .07) = 38.73 and (2.58 / .51) = 5.11 times higher for 2-year-old boys who are members of the second latent class than for those who belong to the first and third latent class, respectively. *Third, the odds of being rated in rating category 3 (i.e., often or very true) tend to be higher for members of the third latent class than for those who belong to the second latent class. And, in turn, the odds of being rated in rating category 3 tend to be higher for those who belong to the second latent class than for those who belong to the first latent class.* Consider the odds of being rated in rating category 3 on the first behaviour symptom (i.e., Gets into many fights?—*abecq6g*) for boys. For instance, at two years of age, the odds were (.59 / .41) = 1.43 for those who are members of the third latent class (see Table 3). Comparatively, the odds were only (.04 / .96) = .04 and (.002 / .998) = .002 for those who are members of the second and first latent class, respectively (see Table 3). Hence the odds of being rated in rating category 3 were (1.43 / .04) = 33.69 times higher for 2-year-old boys who are members of the third latent class than for those who belong to the second latent class. Similarly, the odds of being rated in rating category 3 were (.04 / .002) = 26.47 times higher for 2-year-old boys who are members of the second latent class than for those who are members of the first latent class. Thus, the estimated conditional behaviour symptom rating probabilities allow for a clear characterization of the latent classes under the unrestricted three-class model. A first latent class which we shall refer to as *low-aggressive* whose members do not tend to manifest the behaviour symptoms in question. A second latent class which we shall refer to as *medium-aggressive* whose members tend to manifest the behaviour symptoms in question but only occasionally. And, finally, a third latent class which we shall refer to as *high-aggressive* whose members tend to often manifest the behaviour symptoms in question.

Inspection of the estimates of the latent class probabilities, πt, reveals that a majority of children in the population were estimated to belong to the low-aggressive latent class. For instance, at two years of age, the estimated proportion of boys and girls belonging to the low-aggressive was 62 and 77 per cent, respectively (see Table 4). Comparatively, only a small but nonetheless significant percentage of the population of children were estimated to belong to the high-aggressive latent class. For instance, at two years of age, the estimated proportion of boys and girls belonging to the high-aggressive latent class was 4 and 2 per cent, respectively (see Table 4). Figure 7 and Figure 8 display the estimated latent class probabilities for boys and girls, respectively.

3.3 Predicting Latent Class Membership Under the Unrestricted Three-class Model

We are now in a position to infer from each child's response pattern his or her latent class membership (i.e., whether he or she belongs to the low-, medium- or high-aggressive latent class). As mentioned above, the assignment rule is based on the probability of a child being in latent class t (T = 1, 2, 3) given his or her observed response pattern. Each child was assigned to the latent class for which the probability of his or her response pattern is maximum.

Table 5 shows the predicted latent class for each observed response pattern. The percent of children correctly classified into the three latent classes is also reported in Table 3. Generally, over 90 per cent of children were correctly classified into the latent classes. This indicates an excellent ability to predict the child's latent class from his or her observed response pattern.

Table 6 presents the posterior conditional probability of membership for each latent class given children's predicted latent class membership. Inspection of Table 6 reveals that the posterior conditional probability of membership in the high-aggressive latent class for children who were predicted to belong to this latent class is very high. For instance, for two-year-old boys, the predicted value positive was estimated at .90. Hence, among 2-year-old boys who were predicted to belong to the high-aggressive latent class the odds of being high aggressive are .90 to .10; that is, 9.11 (i.e., the diagnostic information). Further inspection of Table 6 reveals that the posterior conditional probability of nonmembership in the high-aggressive latent class for children who were not predicted to belong to this latent class is very high. For instance, for two-year-old boys, the predicted value negative was estimated at .99 and .96 for children who were predicted to belong to the low- and medium-aggressive latent class, respectively. Hence, the odds of being high-aggressive are [(.90 / .10) / (.01 / .99)] = 15,213.33 and [(.90 / .10) / (.04 / .96)] = 225.73 times higher among 2-year-old boys who were predicted to belong to the high-aggressive than among those who were predicted to belong to the low- and medium-aggressive latent class,

Figure 7
Estimated latent class probabilities under the unrestricted three-class model, 2- to 11-year-old boys

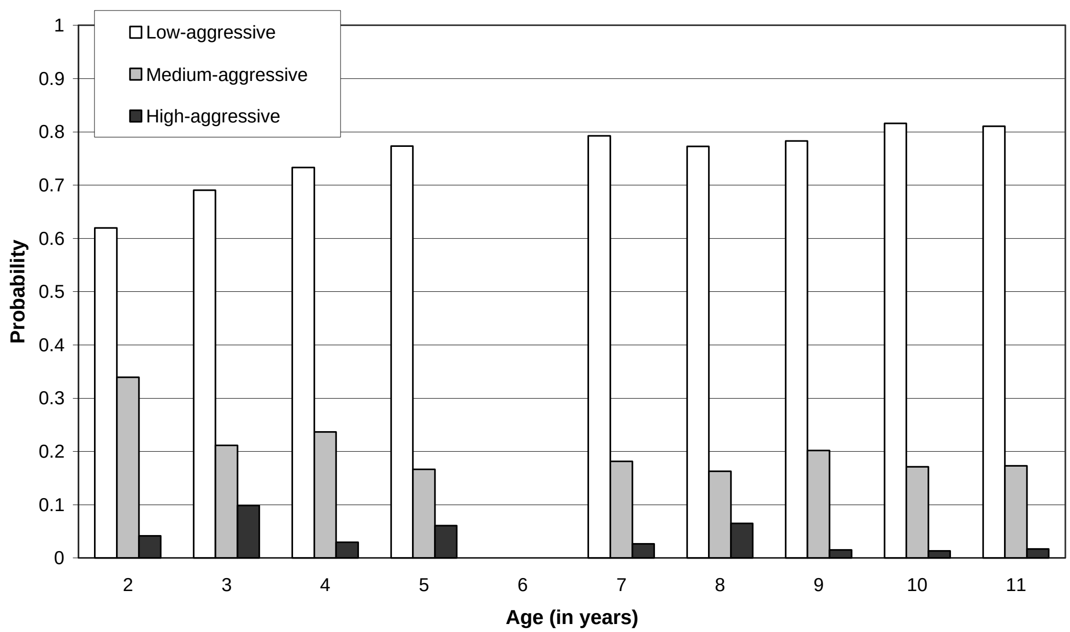
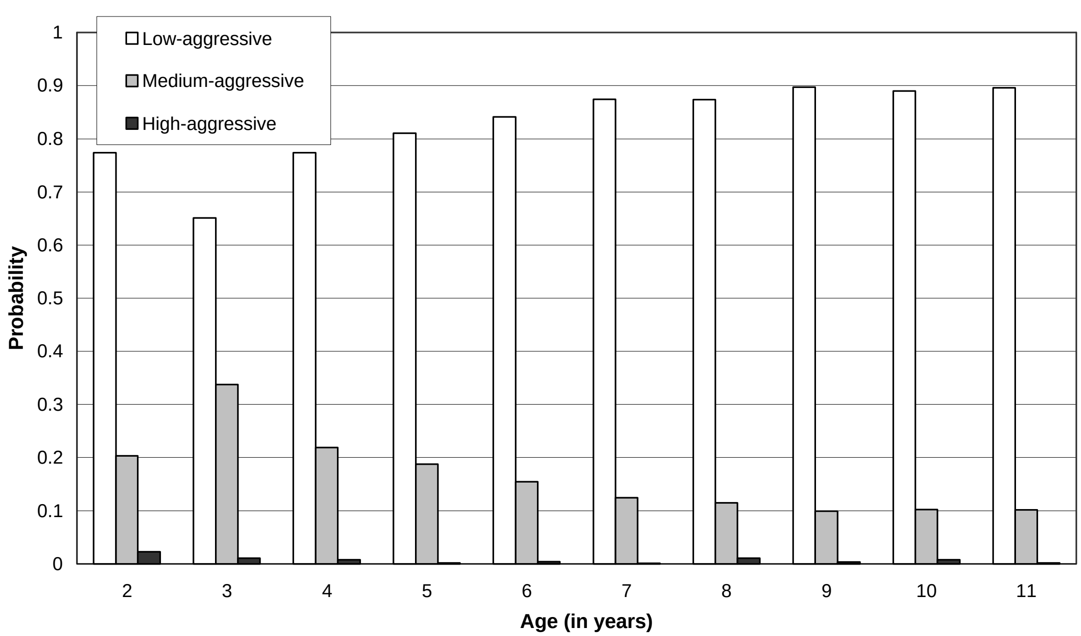


Figure 8
Estimated latent class probabilities under the unrestricted three-class model, 2- to 11-year-old girls



respectively. These results suggest that the assignment rule used to predict latent class membership permits the identification of a homogeneous group of high-aggressive children. That is, there are relatively few children who were predicted to belong to the high-aggressive latent class who actually do not manifest the characteristics of high-aggressive children (as defined by the conditional behaviour symptom rating probabilities presented in Table 4); and, in addition, there are relatively few children who were predicted not to belong to the high-aggressive latent class who actually manifest the characteristics of high-aggressive children.

Table 5

Predicted Latent Class Membership Under the Unrestricted Three-Class Model

Response pattern	**Age (years)**																			
	2		3		4		5		6		7		8		9		10		11	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
l l l	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	L
2 l l	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	L
3 l l	M	L	L	L	L	L	L	L		L	L	L	L	L	M	L	L	L	L	L
l 2 l	L	L	L	L	L	L	L	L		L	L	L	L	M	L	L	M	L	L	L
2 2 l	M	L	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M
3 2 l	M	M	L	M	M	M	H	M		M	M	M	M	M	M	M	M	M	M	M
l 3 l	M	L	L	L	L	L	H	—		—	M	M	M	L	M	—	L	L	L	M
2 3 l	M	L	M	M	L	M	M	—		—	M	M	M	L	M	—	L	L	L	M
3 3 l	M	L	L	M	H	M	H	—		—	M	M	M	L	M	—	L	L	L	M
l l 2	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	L
2 l 2	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	L	M	M	M
3 l 2	M	M	H	M	M	M	L	M		M	H	M	H	M	M	M	M	M	M	M
l 2 2	M	M	L	M	M	M	M	M		M	M	M	H	M	M	M	M	M	M	M
2 2 2	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M
3 2 2	M	M	H	M	M	M	H	M		M	H	M	H	M	M	M	M	M	M	M
l 3 2	M	L	M	M	H	M	H	—		H	M	M	H	H	M	H	H	L	H	M
2 3 2	M	M	H	M	H	M	M	H		—	M	M	H	H	M	—	H	L	H	M
3 3 2	H	H	H	M	H	H	H	H		H	H	M	H	H	H	H	H	H	H	M
1 l 3	L	L	H	L	M	L	L	M		H	M	—	H	M	M	—	M	M	—	L
2 l 3	M	M	H	H	M	M	L	M		M	M	—	M	M	M	—	M	M	—	L
3 l 3	H	H	H	H	M	M	L	M		H	H	—	H	M	H	—	M	M	—	L
l 2 3	M	M	M	M	M	M	H	M		H	M	—	H	M	M	H	M	M	H	M
2 2 3	M	M	H	M	M	M	M	M		M	M	—	M	M	M	—	M	M	H	M
3 2 3	H	H	H	H	H	H	H	H		H	H	—	H	M	H	H	M	H	H	M
L 3 3	H	L	H	H	H	M	H	—		H	M	—	H	H	H	H	H	—	H	H
2 3 3	H	H	H	H	H	M	M	H		—	M	—	H	H	H	—	H	—	H	H
3 3 3	H	H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H

Note: The first digit of the response pattern refers to the observed rating on the first behaviour symptom (i.e., Gets into many fights?—*abecq6g*); the second digit refers to the rating on the second behaviour symptom (i.e., Reacts with anger and fighting?—*abecq6x* or Physically attacks people?—*abecq6aa*); and the third digit to the rating on the third behaviour symptom (i.e., Kicks, bites, hits other children?—*abecq6nn*). L, M and H refer to the low-, medium- and high-aggressive latent class, respectively. A dash refers to a cell with an expected value of zero for which the class to which these children should be assigned is undetermined. The latent class model reported here for the 11-year-old girls is a restricted three-class model wherein some restrictions were imposed on the conditional behaviour symptom rating probabilities such that $\pi_{j(1)|1} = \pi_{j(3)|3}$, $\pi_{j(2)|1} = \pi_{j(2)|3}$ and $\pi_{j(3)|1} = \pi_{j(1)|3}$. The unrestricted three-class model did not fit the physical aggression data for 6-year-old boys.

Table 6

Posterior Conditional Probabilities of Membership to Each Latent Class for Children who were Predicted to Belong to the Low-, Medium and High-aggressive Latent Class [Latent class (t = 1, 2, 3)]

Boys																												
	Low-aggressive (t = 1) Age (years)										**Medium-aggressive (t = 2)** Age (years)										**High-aggressive (t = 3)** Age (years)							
	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9
Predicted																												
Low	.90	.97	.97	.98	—	.97	.98	.97	.97	.96	.10	.03	.03	.02	—	.03	.02	.04	.03	.05	.00	.00	.00	.01	—	.00	.00	.00
Medium	.10	.27	.14	.17	—	.22	.10	.10	.17	.17	.87	.57	.81	.65	—	.71	.67	.89	.81	.80	.04	.17	.05	.18	—	.08	.23	.02
High	.00	.00	.00	.00	—	.00	.00	.00	.00	.00	.10	.00	.02	.00	—	.24	.03	.08	.00	.00	.90	1.0	.98	1.0	—	.76	.97	.92

Girls																												
	Low-aggressive (t = 1) Age (years)										**Medium-aggressive (t = 2)** Age (years)										**High-aggressive (t = 3)** Age (years)							
	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9	10	11	2	3	4	5	6	7	8	9
Predicted																												
Low	.95	.83	.92	.91	.94	.95	.95	.95	.96	.95	.05	.17	.08	.09	.06	.05	.05	.05	.04	.05	.00	.00	.00	.00	.00	.00	.00	.00
Medium	.20	.09	.10	.05	.05	.07	.02	.08	.05	.08	.79	.90	.90	.95	.94	.93	.91	.91	.95	.93	.02	.01	.00	.00	.01	.00	.07	.01
High	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.16	.06	.02	.01	.32	.00	.00	.04	.32	.95	.84	.95	.98	.99	.68	1.0	1.0

Note: The unrestricted three-class model did not fit the physical aggression data for 6-year-old boys.

3.3.1 Testing the hypothesis of behaviour symptom interchangeability

As mentioned above, the traditional approach for making a formal diagnosis consists of using a cutoff point specified in terms of an arbitrary number of behaviour symptoms. This approach tacitly assumes that the behaviour symptoms are interchangeable and that it does not matter which behaviour symptoms the child displays as long as the number of symptoms exceeds the minimum specified by the cutoff. However, it may be that the behaviour symptoms differ in severity and that two children who manifest the same number of symptoms may nonetheless differ as to their level of the emotional or behavioural problem in question.

A formal test of the hypothesis that the three behaviour symptoms used to assess physical aggression are equally severe can be obtained by imposing equality constraints on the conditional behaviour symptom rating probabilities. That is, for any given latent class, the probability of being rated in any given rating category is constrained to be equal across the three behaviour symptoms. The goodness-of-fit statistics associated with this restricted three-class model are shown in Table 7.

The value of the L^2 associated with this restricted three-class model is 88.17 with 18 degrees of freedom ($p < .00$) and 70.58 with 19 degrees of freedom ($p < .00$), for 2-year-old boys and girls, respectively. Hence, the hypothesis of behaviour symptoms interchange-ability can be rejected for the 2-year-old children ($\alpha = .01$). Further, the hypothesis of behaviour symptoms interchange-ability can be rejected for the other age groups as well (see Table 7). These results suggest that the behaviour symptoms differ in severity. Therefore, if one assumes that the unrestricted three-class model is appropriate for the data, adding up the ratings on the three behaviour symptoms may not constitute a proper way to compare individuals with respect to physical aggression. For instance, at two years of age, boys who would obtain a total score of 7 are, according to the assignment rule described above, either predicted to belong to the medium- or the high-aggressive latent class depending on their response patterns (see Table 5). Hence, children with the same total score do *not* necessarily constitute an homogeneous group of individuals with respect to physical aggression.

Table 7

Pearson and Likelihood-ratio Chi-square Statistics for a Restricted Three-class Model with Equality Restrictions on the Conditional Behaviour Symptoms Rating Probabilities Across Behaviour Symptoms

Age (in years)	**Pearson chi-square** (X^2)		**Likelihood-ratio chi-square** (L^2)		**Degrees of freedom**		**p**[a]	
	M	F	M	F	M	F	M	F
2	91.81	67.35	88.17	70.58	18	19[b]	.00	.00
3	127.95	103.74	138.61	108.95	18	18	.00	.00
4	178.48	195.37	173.75	189.79	18	19[b]	.00	.00
5	229.79	175.82	209.52	172.81	18	19[b]	.00	.00
6	232.41	226.22	226.52	220.96	18	19[b]	.00	.00
7	188.89	229.39	190.59	224.97	18	19[b]	.00	.00
8	246.19	304.90	254.44	300.93	19[b]	19[b]	.00	.00
9	188.78	207.71	190.91	203.87	18	18	.00	.00
10	270.89	338.07	259.48	336.16	19[b]	19[b]	.00	.00
11	215.17	314.94	202.21	307.91	19[b]	19[b]	.00	.00

Note: [a] Significance level associated with the likelihood-ratio chi-square statistic.
[b] Strictly speaking there are 18 degrees of freedom for this model, but a terminal solution was obtained in which one or more conditional behaviour symptom rating probabilities converged to either 0 or 1. Therefore, a new solution was estimated in which these parameters were set a priori equal to that value. This procedure is described and utilized in Clogg (1979) and Goodman (1974a, 1974b). This allows us to assume that L^2 has nonetheless a large sample $\chi 2$ distribution (i.e., L^2 is asymptotically distributed as a chi-square).

3.4 Comparing the Prevalence of Physical Aggression Across Age Groups and Across Sexes

3.4.1 Investigating the relationships of the three behaviour symptoms with sex and age

Figures 9 and 10 display the percentage of children who received ratings in the various response categories for the first behaviour symptom (i.e., Gets into may fights?—*abecq6g*), for boys and girls, respectively. In addition, Figures 11 and 12 present the same information for the second behaviour symptom (i.e., Reacts with anger and fighting?—*abecq6x*—or Physically attacks people?—*abecq6aa*), for boys and girls, respectively. And, in addition, Figures 13 and 14 show the same information for the third behaviour symptom (i.e., Kicks, bites, hits other children?—*abecq6nn*), for boys and girls, respectively. The extent to which the PMKs' ratings on any behaviour symptom vary as a function of children's age and sex can be investigated using log-linear models (Bishop, Fienberg & Holland, 1975). First, we considered the independence model.

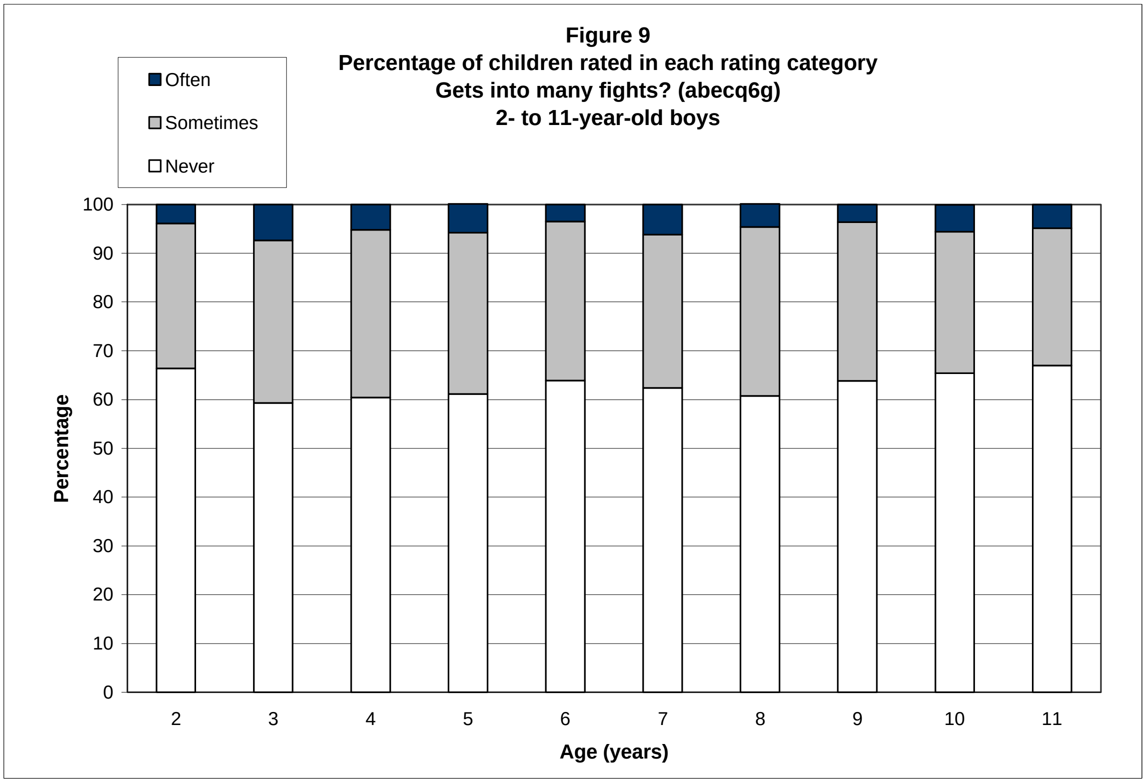


Figure 9
Percentage of children rated in each rating category
Gets into many fights? (abecq6g)
2- to 11-year-old boys
Often
Sometimes
Never
Percentage
0
10
20
30
40
50
60
70
80
90
100
2
3
4
5
6
7
8
9
10
11
Age (years)

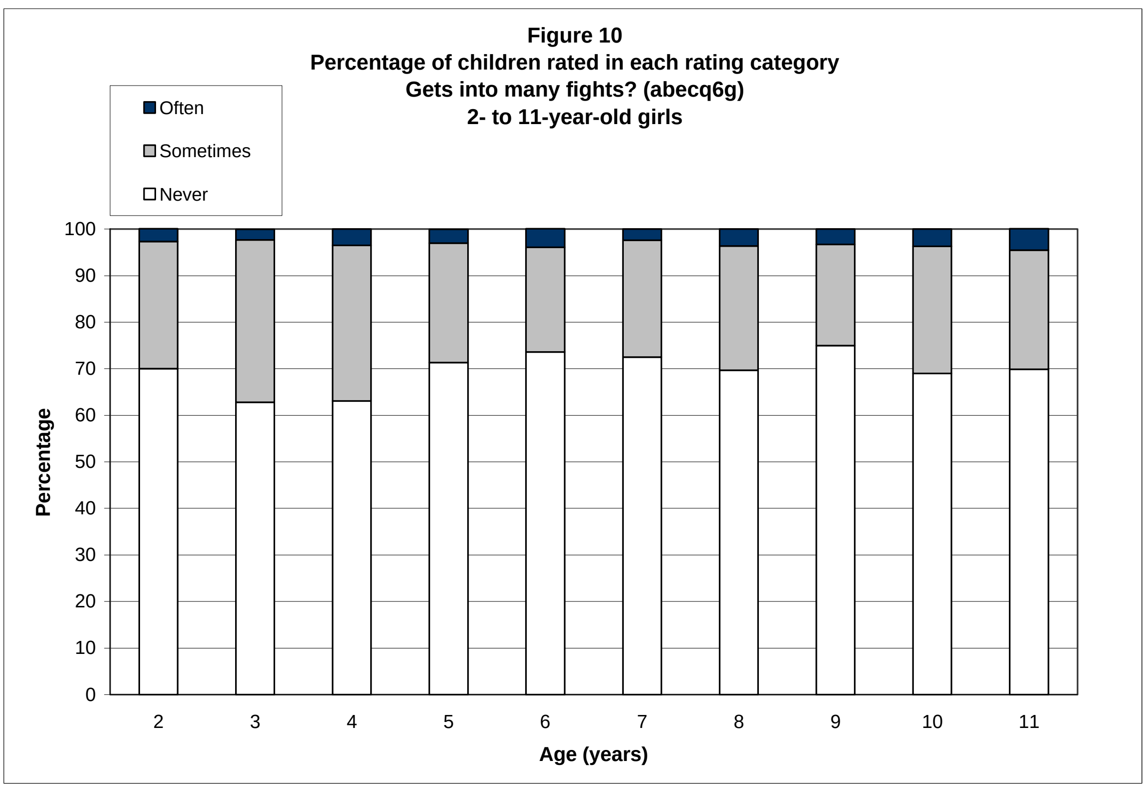


Figure 10
Percentage of children rated in each rating category
Gets into many fights? (abecq6g)
2- to 11-year-old girls
Often
Sometimes
Never
Percentage
0
10
20
30
40
50
60
70
80
90
100
2
3
4
5
6
7
8
9
10
11
Age (years)

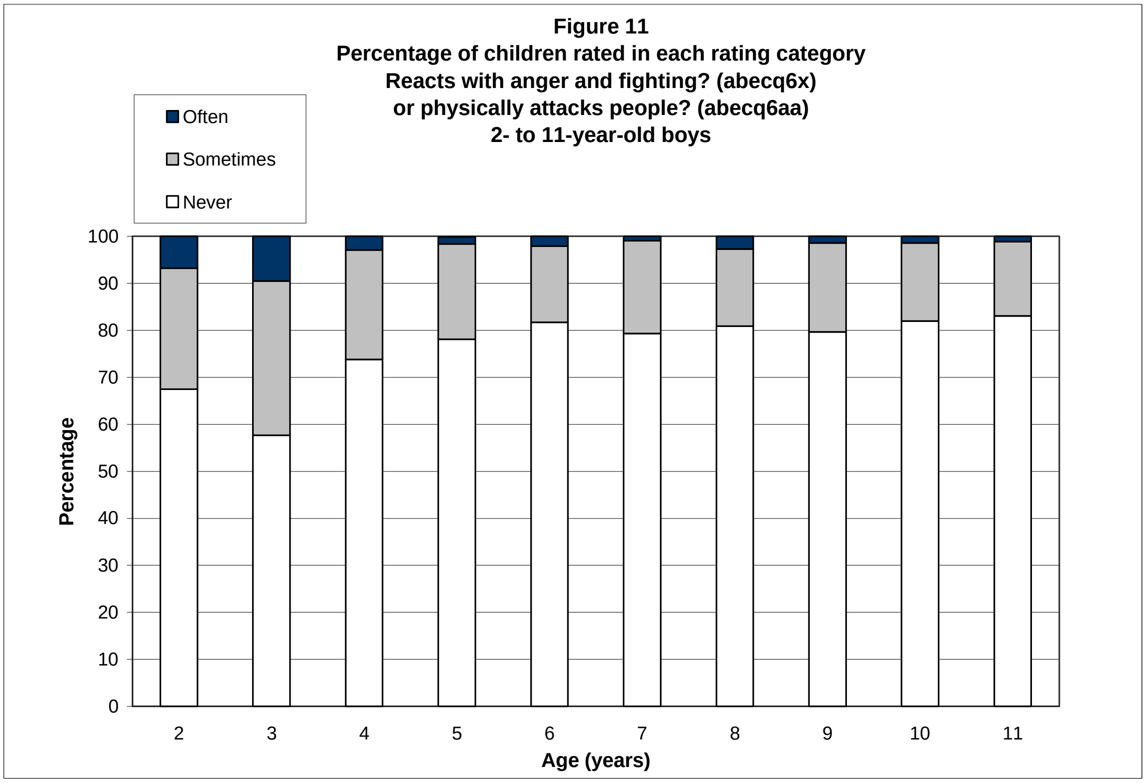


Figure 11
Percentage of children rated in each rating category
Reacts with anger and fighting? (abecq6x)
or physically attacks people? (abecq6aa)
2- to 11-year-old boys
Often
Sometimes
Never
Percentage
100
90
80
70
60
50
40
30
20
10
0
2
3
4
5
6
7
8
9
10
11
Age (years)

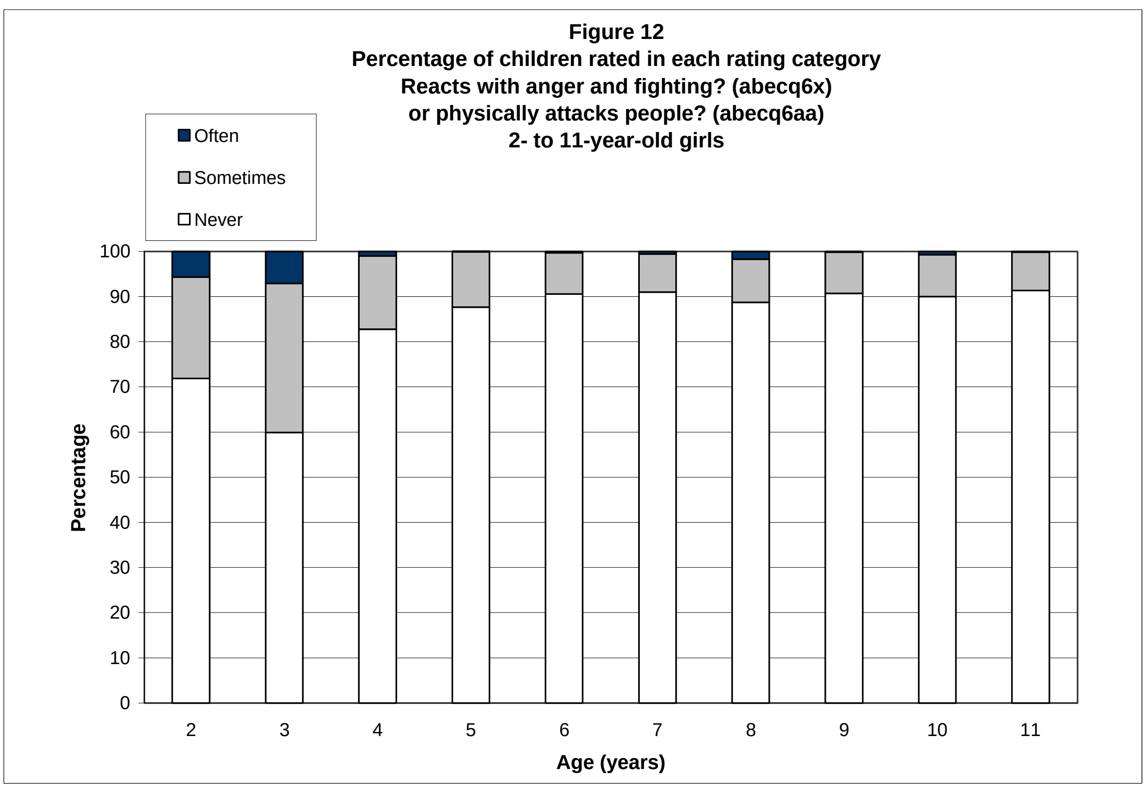


Figure 12
Percentage of children rated in each rating category
Reacts with anger and fighting? (abecq6x)
or physically attacks people? (abecq6aa)
2- to 11-year-old girls
Often
Sometimes
Never
Percentage
100
90
80
70
60
50
40
30
20
10
0
2
3
4
5
6
7
8
9
10
11
Age (years)

Figure 13
Percentage of children rated in each rating category
Kicks, bites, hits other children? (abecq6nn)
2- to 11-year-old boys

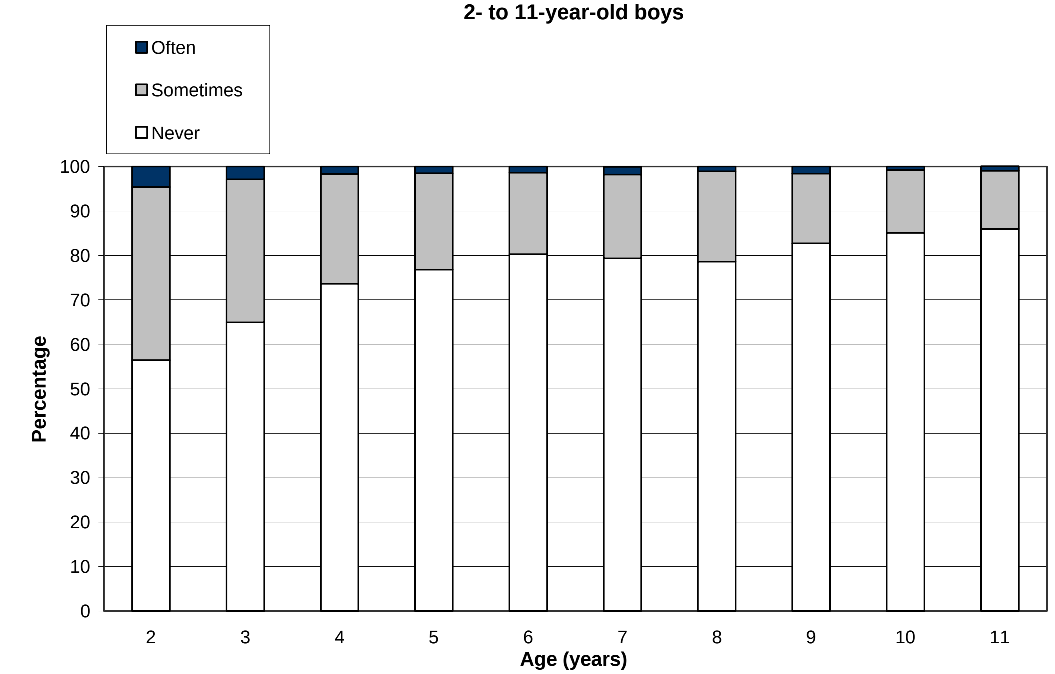
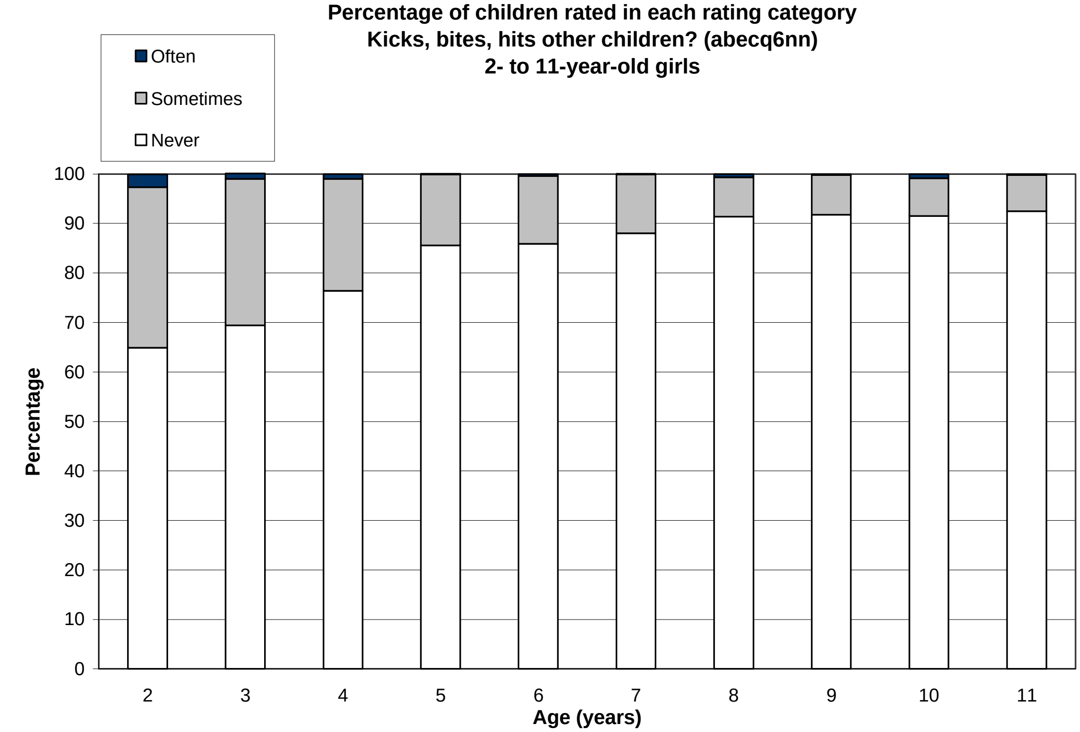


Figure 14
Percentage of children rated in each rating category
Kicks, bites, hits other children? (abecq6nn)
2- to 11-year-old girls



This model assumes that the variables are statistically independent. This model yields a L^2 of 12044.02 with 59 degrees of freedom for the first behaviour symptom (i.e., Gets into many fights—*abecq6g*). Similarly, the L^2 associated with this model for the third behaviour symptom (i.e., Kicks, bites, hits other children?—*abecq6nn*) is 20462.69 with 59 degrees of freedom. Hence, not surprisingly, there seems to exist a very strong relationships among these variables. Second, we considered a model with first- and second-order effects only. This model yields a L^2 of 59.67 with 18 degrees of freedom ($\underline{p} < .00$) for the first behaviour symptom (i.e., Gets into may fights—*abecq6g*). Similarly, the L^2 associated with this model for the third behaviour symptom (i.e., Kicks, bites, hits other children?—*abecq6nn*) is 59.67 with 18 degrees of freedom ($\underline{p} < .00$). Thus, a model with only first- and second-order effects does *not* seem adequate to represent the relationships among these variables. In other words, a third-order effect seems necessary to account for the relationships among these variables suggesting that the extent to which the PMKs' ratings vary as a function of the child's sex depends on his or her age and vice versa. In contrast, a model with only first- and second-order effects yields a L^2 of 1.63 with 2 degrees of freedom ($\underline{p} < .44$) for the second behaviour symptom (i.e., Reacts with anger and fighting?—*abecq6x*) for 2- and 3-year-old children. Moreover, this model represents a decrease of 2045.14 with 9 degrees of freedom from the independence model ($L^2 = 1.63 - 2046.78 = 2045.14$, $\underline{df} = 11 - 2 = 9$, $\underline{p} < .00$). Among the various second-order effects only the age by behaviour symptom effect reached significance ($\alpha = .01$) ($X^2 = 48.62$, $\underline{df} = 2$, $\underline{p} < .00$) suggesting that the PMKs' ratings on this behaviour symptom vary as a function of the child's age only. Similarly, a model with only first- and second-order effects yields a L^2 of 23.27 with 14 degrees of freedom ($\underline{p} < .06$) for the second behaviour symptom (i.e., Physically attacks people?—*abecq6aa*) for 4- to 11-year-old children. Further, this model represents a decrease of 17735.63 with 33 degrees of freedom from the independence model ($L^2 = 23.27 - 17758.90 = 17735.63$, $\underline{df} = 47 - 14 = 33$, $\underline{p} < .00$). Within this model both the age by behaviour symptom ($X^2 = 100.54$, $\underline{df} = 14$, $\underline{p} < .00$) and the sex by behaviour symptom ($X^2 = 239.12$, $\underline{df} = 2$, $\underline{p} < .00$) effects have reached significance suggesting that the PMKs' ratings on this behaviour symptom vary as a function of both the child's age and sex. All in all, the PMKs' ratings on the three behaviour symptoms seem to vary as a function of both the child's age and sex. The extent to which these observed differences in the PMKs' ratings imply differences in the prevalence of physical aggression between boys and girls and/or across the different age groups will be investigated next.

3.4.2 Comparing the prevalence of physical aggression in children from 2 to 11 years of age

As mentioned above, the traditional approach for making a formal diagnosis uses the same cutoff score irrespective of the sex and/or the age of the child. This approach tacitly assumes that any observed difference between children who differ in terms of their age and/or sex is due to a true difference in the prevalence of the emotional or behavioural problem in question. However, it may that the observed differences between children of different age and/or sex are due to the fact that the behaviour symptoms are not necessarily functioning the same way depending on children's sex and/or age. For example, the propensity to manifest the three behaviour symptoms used to assess physical aggression may be higher in boys than in girls because these behaviours are more socially acceptable for the former than for the latter (see Peppler & Slaby, 1994). Therefore, the prevalence of physical aggression may or may *not* differ between boys and girls once we take into account the factors that affect the way these behaviour symptoms function in the two groups. Similarly, the prevalence of physical aggression may or may *not* differ across age groups once we take into account the factors that affect the way the behaviour symptoms function in different age groups.

A formal test of the hypothesis that the prevalence of physical aggression is the same across age different groups for children of the same sex can be obtained by imposing equality restrictions on the latent class probabilities. That is, for any given sex, the latent class probabilities are constrained to be equal across age groups. The goodness-of-fit statistics associated with this restricted three-class model are shown in Table 8.

First, we considered a restricted three-class model which assumes that the prevalence of physical aggression is the same between 2 and 11 years of age among girls. The value of the L^2 associated with this restricted three-class model is 173.75 with 131 degrees of freedom ($p < .01$). Hence, the hypothesis of homogeneity in the estimated latent class probabilities between 2 and 11 years of age among girls is rejected. Similarly, a restricted three-class model which assumes that the prevalence of physical aggression is the same between 3 and 11 years of age among girls is also rejected (see Table 8). In contrast, a restricted three-class model which assumes that the prevalence of physical aggression is the same between 4 and 11 years of age among girls can *not* be rejected (see Table 8). However, this model represents an increase of 37.39 in L^2 with a

Table 8

Pearson and Likelihood-ratio Chi-Square Statistics for Some Multi-Group Latent Class Models for Comparing the Prevalence of Physical Aggression Across Age Groups

Model	**Pearson chi-square** (X^2)		**Likelihood-ratio chi-square** (L^2)		**Degrees of freedom**		**p**[a]		**% of variance**	
	M	F	M	F	M	F	M	F	M	F
Independence	17,700.40	38451.44	4,827.02	4,334.80	180	200	.00	.00		
Unrestricted three-class 2- to 11-year-olds	80.97	72.72	92.85	82.05	85[b]	113[c]	26	.99	98	98
RTC 2- to 11-year-olds	139.70	159.64	152.05	173.75	101	131	.00	.01	97	96
RTC 3- to 11-year-olds	120.70	146.25	132.46	160.11	99	129	.01	.03	97	96
RTC 4- to 11-year-olds	111.84	107.78	119.73	119.45	97	127	.06	.67	98	97
RTC 5- to 11-year-olds	106.62	94.59	114.32	105.12	95	125	.09	.90	98	98
RTC 6- to 11-year-olds		86.40		96.28		123		.96		98
RTC 7- to 11-year-olds	95.14	81.03	103.72	91.30	93	121	.21	.98	98	98
RTC 8- to 11-year-olds	91.45	75.89	103.27	86.36	91	119	.18	.99	98	98
RTC 9- to 11-year-olds	84.58	74.30	95.78	84.93	89	117	.29	.99	98	98
RTC 10- to 11-year-olds	81.19	74.13	93.09	84.09	87	115	.31	.99	98	98
RTC 2- to 10-year-olds	135.25	154.50	148.78	169.40	99	129	.00	.01	97	96
RTC 3- to 10-year-olds	116.98	141.88	130.06	156.51	97	127	.01	.04	97	96
RTC 4- to 10-year-olds	109.78	105.47	118.22	117.88	95	125	.05	.66	98	97
RTC 5- to 10-year-olds	104.81	93.32	113.22	104.42	93	123	.08	.89	98	98
RTC 6- to 10-year-olds		85.51		95.67		121		.96		98
RTC 7- to 10-year-olds	94.36	80.05	103.14	90.21	91	119	.18	.98	98	98
RTC 8- to 10-year-olds	90.69	74.55	102.66	84.35	89	117	.15	.99	98	98
RTC 9- to 10-year-olds	84.35	72.67	95.55	82.93	87	115	.25	.99	98	98
RTC 2- to 9-year-olds	108.97	142.71	124.89	156.42	97	127	.03	.04	97	96
RTC 3- to 9-year-olds	93.81	130.60	110.26	143.68	95	125	.14	.12	98	97
RTC 4- to 9-year-olds	90.04	98.01	104.26	109.51	93	123	.20	.80	98	97
RTC 5- to 9-year-olds	81.83	88.98	98.38	98.92	91	121	.28	.93	98	98
RTC 6- to 9-year-olds		83.37		92.58		119		.97		98
RTC 7- to 9-year-olds	79.79	79.76	95.72	88.93	89	117	.29	.98	98	98
RTC 8- to 9-year-olds	82.82	74.40	94.94	84.24	87	115	.26	.99	98	98
RTC 2- to 8-year-olds	103.80	132.36	120.65	144.91	95	125	.04	.11	98	97
RTC 3- to 8-year-olds	90.16	121.48	107.64	133.77	93	123	.14	.24	98	97
RTC 4- to 8-year-olds	84.67	91.61	103.07	102.90	91	121	.18	.88	98	98
RTC 5- to 8-year-olds	77.48	84.47	95.87	94.64	89	119	.29	.95	98	98
RTC 6- to 8-year-olds		80.11		89.86		117		.97		98
RTC 7- to 8-year-olds	78.42	78.20	95.12	87.66	87	115	.26	.97	98	98
RTC 2- to 7-year-olds	100.66	124.45	117.52	133.89	93	123	.04	.24	98	97
RTC 3- to 7-year-olds	88.71	111.44	106.15	121.63	91	121	.13	.47	98	97
RTC 4- to 7-year-olds	87.17	85.51	101.69	95.25	89	119	.17	.95	98	98
RTC 5- to 7-year-olds	77.82	79.53	95.59	87.23	87	117	.25	.98	98	98
RTC 6- to 7-year-olds		76.92		84.50		115		.99		98
RTC 2- to 6-year-olds		107.31		111.94		121		.71		97
RTC 3- to 6-year-olds		98.83		108.52		119		.74		97
RTC 4- to 6-year-olds		78.10		88.09		117		.98		98
RTC 5- to 6-year-olds		74.68		83.70		115		.99		98

Table 8 (Continued)

RTC 2- to 5-year-olds	101.57	95.72	112.68	104.72	91	119	.06	.82	98	98
RTC 3- to 5-year-olds	90.69	88.00	102.34	96.76	89	117	.16	.91	98	98
RTC 4- to 5-year-olds	89.05	75.00	99.15	84.25	87	115	.18	.99	98	98
RTC 2- to 4-year-olds	92.53	84.02	103.61	94.20	89	117	.14	.94	98	98
RTC 3- to 4-year-olds	85.30	80.81	97.46	89.89	87	115	.21	.96	98	98
RTC 2- to 3-year-olds	85.09	77.95	97.25	88.32	87	115	.21	.97	98	98

Note: The unrestricted three-class model did not fit the physical aggression data for 6-year-old boys. RTC=Restricted three-class model with equal latent class probabilities across groups.

[a] Significance level associated with the likelihood-ratio chi-square statistic.

[b] Strictly speaking there are 54 degrees of freedom for this model, but a terminal solution was obtained in which one or more conditional behaviour symptom rating probabilities converged to either 0 or 1. Therefore, a new solution was estimated in which these parameters were set a priori equal to that value. This procedure is described and utilised in Clogg (1979) and Goodman (1974a, 1974b). This allows us to assume that L^2 has nonetheless a large sample $\chi 2$ distribution (i.e., L^2 is asymptotically distributed as chi-square).

[c] Strictly speaking there are 60 degrees of freedom for this model, but a terminal solution was obtained in which one or more conditional behaviour symptom rating probabilities converged to either 0 or 1. Therefore, a new solution was estimated in which these parameters were set a priori equal to that value (see justification above).

corresponding increase of 14 in the degrees of freedom from the unrestricted model (L^2 = 119.45 - 82.05 = 37.39, df = 127 - 113 = 14, p < .00). Since this increase in L^2 is large compared to the increase the degrees of freedom this suggests that the hypothesis of homogeneity in the estimated latent class probabilities between 4 and 11 years of age among girls is too restrictive. This has lead us to consider a restricted three-class model which assumes that the prevalence of physical aggression is the same between 5 and 11 years of age among girls. The value of the L^2 associated with this model is 105.12 with 125 degrees of freedom (p < .90). Moreover, this model does *not* represent a significant decrement in fit from the unrestricted three-class model (L^2 = 105.12 - 82.05 = 23. 06, df = 125 - 113 = 12, p < .03). And, moreover, other restricted three-class models that are nested within this model also fit the physical aggression data for girls and, in addition, they do not represent a significant decrement in fit over the unrestricted three-class model (see Table 8). These results seem to suggest that the prevalence of physical aggression may not vary among girls between the age of 5 and 11 years once we take into account that the three behaviour symptoms may function differently depending on the age of the child. Second, we considered a restricted three-class model which assumes that the prevalence of physical aggression is the same between 2 and 4 years of age among girls. This model yields a L^2 of 94.20 with 117 degrees of freedom (p < .94). Furthermore, this model does *not* represent a significant decrement in fit from the unrestricted three-class model (L^2 = 94.20 - 82.05 = 12.14, df = 117 - 113 = 4, p < .02). And, furthermore, other restricted three-class models that are nested within this model also fit the physical aggression data for girls and, in addition, they do *not* represent a significant decrement in fit over the unrestricted three-class model (see Table 8). These results indicate that the prevalence of physical aggression among girls do *not* seem to vary between 2 and 4 years of age.

We have obtained very similar results for boys. First, a restricted three-class model which assumes that the prevalence of physical aggression is the same among boys between 5 and 11 years of age yields a L^2 of 114.32 with 95 degrees of freedom ($p < .09$). Moreover, this model does *not* represent a significant decrement in fit from the unrestricted three-class model (L^2 = 114.32 - 92.85 = 21. 48, *df* = 95 - 85 = 10, $p < .02$). And, moreover, other restricted three-class models that are nested within this model also fit the physical aggression data for boys; and, in addition, they do *not* represent a significant decrement in fit over the unrestricted three-class model (see Table 8). Second, we considered a restricted three-class model which assumes that the prevalence of physical aggression is the same between 2 and 4 years of age among boys. This model yields a L^2 of 103.61 with 89 degrees of freedom ($p < .14$). Furthermore, this model represents an increase of only 10.76 in L^2 with an increase of 4 degrees of freedom from the unrestricted three-class model (L^2 = 103.61 - 92.85 = 10.76, *df* = 89 - 85 = 4, $p < .03$). And, furthermore, other restricted three-class models that are nested within this model also fit the physical aggression data for boys; and, in addition, they do *not* represent a significant decrement in fit over the unrestricted three-class model (see Table 8). These results indicate that the prevalence of physical aggression among boys do *not* seem to vary between 5 and 11 years of age and between 2 and 4 years of age.

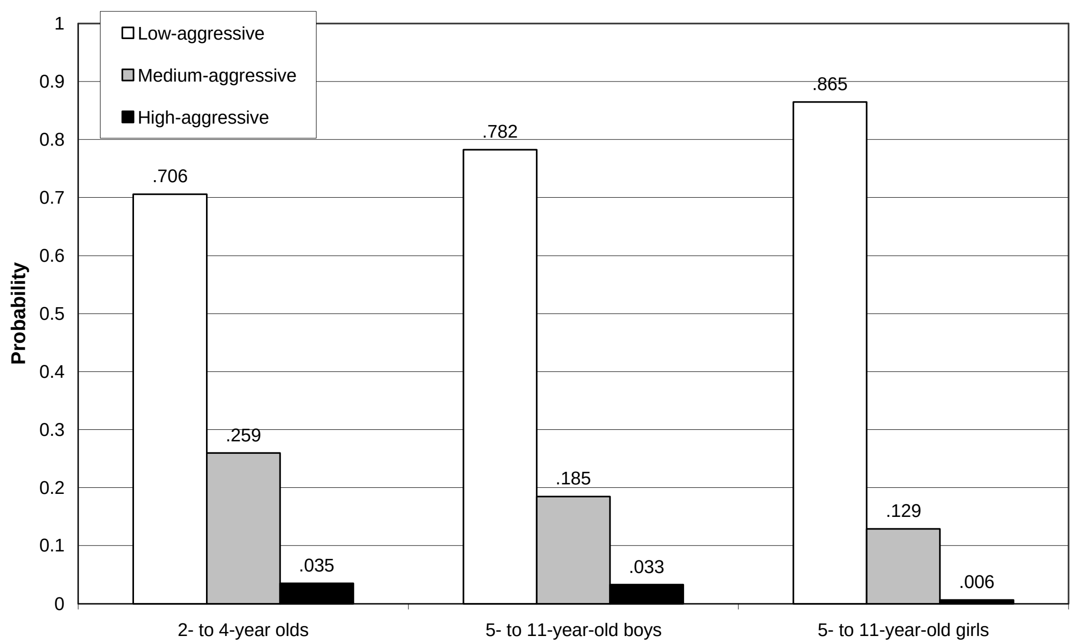
3.4.3 Comparing the prevalence of physical aggression between boys and girls

We are now in a position to compare the prevalence of physical aggression between boys and girls. First, we considered a restricted three-class model which assumes that the prevalence of physical aggression is the same between boys and girls from 2 to 4 years of age. The value of the L^2 associated with this model is 90.73 with 60 degrees of freedom ($p < .01$). Hence, the hypothesis of homogeneity in the latent class probabilities between boys and girls from 2 to 4 years of age can *not* be rejected. Moreover, this model represents an increase of only 8.44 in L^2 with an increase of 2 degrees of freedom over the restricted three-class model which assumes that the prevalence of physical aggression is the same between 2 and 4 years of age for each sex (L^2 = 90. 73 - 82.29 = 8.44, df = 60 -58 = 2, $p < .02$). These results suggest that the prevalence of physical aggression may be the same between boys and girls for the period ranging from 2 to

4 years of age. Second, we considered a restricted three-class model which assumes that the prevalence of physical aggression is the same between boys and girls for the period ranging from 5 to 11 years of age. The L^2 associated with this model is 176.09 with 167 degrees of freedom ($\underline{p} < .30$). However, this model represents a significant decrement of fit over the restricted three-class model which assumes that the prevalence of physical aggression is the same between 5 and 1 years of age within each sex ($L^2 = 176.09 - 143.71 = 32.38$, $\underline{df} = 167 - 165 = 2$, $\underline{p} < .00$). These results seem to suggest that the prevalence of physical aggression is *not* the same between boys and girls from 5 and 11 years of age.

Figure 15 displays the latent class probabilities estimated under these restricted three-class models. Between 2 and 4 years of age, the proportion of Canadian children who belong to the high-aggressive latent class was estimated at 3.5 per cent, the same for boys and girls. Between 5 and 11 years of age the proportion of Canadian children who belong to this latent class was estimated at 3.3 and .6 per cent, for boys and girls, respectively. Note that the odds of belonging to the high-aggressive latent class were [(.033 / .967) / (.006 / .994)] = 5.34 times higher for boys than for girls between 5 and 11 years of age. Further, note that the odds of belonging to the high-aggressive latent class were [(.035 / .965) / (.006 / .994)] = 5.75 times higher for girls between 2 and 4 years of age than for those between 5 and 11 years of age. In comparison, the odds of belonging to the high-aggressive latent class were practically the same between 2 and 11 years of age for boys [(.035 / .965) / (.033 / .967)] = 1.08.

Figure 15
Estimated latent class probabilities under the restricted three-class model
2- to 11-year-old children



4. Conclusion

Physical aggression affects a significant segment of the Canadian population of children. Using the data from the first collection cycle of the National Longitudinal Survey of Children and Youth we have estimated at 3.5 the percentage of 2- to 4-year-old children in the Canadian population who, according to the person most knowledgeable about the child, are often manifesting physically aggressive behaviours. This percentage is practically the same for boys between 5 and 11 years of age (i.e., 3.3 per cent) whereas it is substantially lower for girls (i.e., .6 per cent). Essentially, these children can be characterized by a propensity to manifest physically aggressive behaviours that is many times higher than that of the other children of the same age and sex in the Canadian population. Although physical aggression affects a significant segment of the Canadian population of children the majority of them tend not to display an abnormally high propensity to manifest physically aggressive behaviours. Among them are those who tend to manifest physically aggressive behaviours only occasionally. It remains to be seen whether these children are at a higher risk of experiencing other behaviour problems like hyperactivity and by so doing become a source of concerns for their environment and whether they may be at a higher risk to become violent adolescents in the future.

Issues of measurement have not been given sufficient attention when trying to devise methods to make a formal diagnosis of behaviour problems. Our results suggest that latent class analysis approach could provide a unified framework for combining the PMKs' (and possibly other informants as well) ratings on many behaviour symptoms into a formal diagnosis while taking into account measurement errors. First, we have shown how latent class analysis can be used to identify a set of mutually exclusive and exhaustive types of individuals that differ markedly in their propensity to manifest the behaviour symptoms in question. It provides the empirical means for deciding on an appropriate number (two or more) of types of individuals on the basis of the available data. Second, we have shown how the proportion of children in the Canadian population who belong to the various latent classes can be estimated from the available data. Given the presence of measurement error in the PMKs' ratings, latent class analysis provides the means to estimate the conditional probability of manifesting the behaviour symptoms given membership in each of the latent classes. Third, we have shown how the latent class approach can be used to predict latent class membership for each individual based on his or her observed ratings. Given the inherent uncertainty attached to the process of making a formal diagnosis (i.e., a child’s diagnosis can only be arrived at in a probabilistic manner) the latent class approach provides a framework in which the predictive value positive (i.e., the posterior conditional probability of having the disorder given a positive test result) and the predictive value negative (i.e., the posterior conditional probability of not having the disorder given a negative test result) can be estimated from the available data. Fourth, we have shown how the latent class approach can be used to compare the prevalence of physical aggression across groups.

Although this study was mainly of a methodological nature, these results have important public policy implications. First, this study provides, for the first time, public health policy analysts with very precious information as to the prevalence of physical aggression in the Canadian population of children 2 to 11 years of age. Without such information it has been very difficult in the past to justify the necessary resources for helping behaviourally disorder children in Canada. We believe that these prevalence estimates should help to evaluate the need for mental health services for behaviourally disordered children and estimate the costs of these services at the community, regional, provincial and national level. Second, this study provides a clear operational definition of what constitutes a physically aggressive child in Canada in terms of his or her propensity to manifest physically aggressive behaviours. Without such a definition it has been hard in the past to design cost effective programs that are adapted to the needs of behaviourally disordered children in Canada. Therefore, we believe that this operational definition should help in the planning of mental health services in the future. Third, this study provides the means of identifying children whose propensity to manifest physically aggressive behaviours is many times higher than that of the other children of the same age and sex in the Canadian population. This is especially important if the scarce public resources for mental health services are to be channeled toward those most in need of them. Without such instruments it has proven to be very difficult in the past to intervene before these children become violent adolescents. The prognosis for children treated early in their life is much better than the prognosis for those who are treated when the pattern behaviour problems is already well established (Tremblay & Craig, 1995; Tremblay et al., 1995). Considering the enormous costs of violence to society we believe that the early identification and treatment of those behaviourally disordered children should constitute a high priority for mental health services in Canada.

This study has important limitations, however. First, the prevalence estimates were derived using a single source informant, namely, the person most knowledgeable about the child, in most cases the mother. Hence, the need to validate these estimates using other sources of information about children's physically aggressive behaviour. Information from other informants is also available in the NLSCY; namely, for school-aged children, the child's teacher and for children aged 10 or 11 their own self-report are also available. Second, the prevalence estimates are cross-sectional not longitudinal. Therefore, there is a potential confounding of age with generation because children of the same age were necessarily born the same year (see Schaie, 1965). Hence, there is a need to use data from subsequent collection cycles to obtain longitudinal estimates of the prevalence of physical aggression. Third, the prevalence estimates are purely descriptive and static. As such, they do not tell us anything about change in the level at which children manifest physically aggressive behaviours over time. Recent results indicate that there is a great deal of intraindividual change in physical aggression throughout childhood (see Baillargeon, Tremblay, Vitaro, Zoccolillo & Romano, submitted for publication). Hence, the child's status (i.e., either low-, medium- or high-aggressive) may change over time, and therefore, should *not* be considered an immutable characteristic of that child. Fourth, the external validity of the three latent classes remains to be investigated. That is it remains to be seen how children from the three latent classes may differ in a range of other variables. Fifth, the issue of comorbidity has not been addressed in this study. Children from the three latent classes may differ in their likelihood to present other childhood disorders as well.

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