Evaluating a bicycle education program for children: Findings from Montreal, Canada

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ABSTRACT

Many cities are developing policies that promote cycling due to the positive environmental, economic, and health benefits. Promoting bicycle usage amongst school-aged children is particularly important as it is one way to encourage more active lifestyles. The purpose of this paper is to evaluate an on- and off-bicycle education program for school-aged children in Montreal, Canada with the goal of understanding how education influences children's and parents' cycling behavior and attitudes. Using qualitative measures and descriptive statistics this paper analyses pre- and post-program survey results from children who participated in the program and their parents. Results show that children's knowledge of bicycle safety increased and that participants made significant improvements in knowing bicycle-specific street signs and hand signals. Children also became more confident: before the program 75% of children stated that riding a bicycle was not difficult for them and after, this increased to 92%. Students' parents also reported improvements in their children's cycling abilities, and 55% stated that they would allow their children to participate in an organized "cycle-to-school" program. In addition, half of the parents included in the post-program survey stated that their behaviors and/or attitudes towards cycling had positively changed as a result of their child's involvement in the bicycle education program. To encourage cycling in any region, bicycle educators and advocacy groups need to develop school-based bicycle education programs as well as "cycle-to-school" programs. While city planners should consider implementing policies that encourage the development of bicycle-infrastructure and traffic calming measures, especially near schools in order to encourage parents to allow their children to bicycle to school.

Keywords: Cycling, Education, Evaluation, Children, Adults, Behavior, Safety

INTRODUCTION

Many cities are developing policies that promote the use of sustainable modes such as walking and cycling due to their positive environmental, economic, health and social benefits (*1-3*). Recent research has often focused on cyclists' existing travel behavior and their experience and satisfaction with the built environment (*4-8*). Several researchers have specifically focused on ways to promote bicycling to adults who are not cycling (*9*), and on ways to increase cycling frequency among different groups of existing cyclists (*10*). An increase in bicycle mode share poses many benefits for cities and therefore cycling advocacy groups around the world are developing programs to promote bicycle usage amongst adults and school-aged children as a way to encourage more active, and less sedentary, lifestyles (*11-13*).

Educating school-aged children about certain habits has shown to be an effective way to change behavior among future generations (*10; 14*), as well as among their parents (*15; 16*). In 2014, *Vélo Québec*, a local cycling advocacy group in Montreal, Canada, in collaboration with one of Montreal's public school boards, started a pilot program to teach children about bicycle safety using on- and off-bicycle instruction. The program is known as *Certificat Cycliste Averti* (CCA) and the English translation of the originally French program name is "Certified Aware Cyclist."

The present study, to our knowledge, is the first to assess a bicycle education program in Canada and focusses on assessing the CCA program through an analysis of pre- and post-surveys of children and parents who were exposed to the CCA in 2015. This paper, which assesses the success and influences of the CCA program, begins with a brief literature review, followed by a description of the program and then discusses the data and methods used. Next, it analyses the results of the surveys and focuses specifically on the changes in attitudes and behaviors of children and adults before and after the CCA program. Finally, the paper concludes with a discussion of the results and accordingly recommends relevant policies.

PREVIOUS RESEARCH

Physical Activity and Cycling Among School-Aged Children

In recent years many studies have found that children and youth are not meeting the recommended amount of daily physical activity, which can result in negative health outcomes. In Canada specifically, school-aged children are recommended to engage in at least 60 minutes of moderate- to vigorous-intensity physical activity every day (*17*). However, currently only 5% of school-aged Canadian children are reaching the recommended amount (*18*). A simple way to engage in daily physical activity is by using active transportation such as walking and cycling to get to school, but in a recent survey of Canadian parents, only 24% claimed that children always travelled to school by a non-motorized mode, while 62% said that their children always used inactive modes. More specifically, of those who used active transportation, 20% walked, 1% used a bicycle, and 3% used a combination of walking and cycling (*19*).

Physical activity, such as using a bicycle, is important for children and youth, as increases in physical activity are linked to minimizing cardiovascular disease risk factors improving other physiological health outcomes (*20-22*). In addition, many studies have found that increases in physical activity lead to improvements in cognitive function such as performance at school (*23; 24*) and mental health (*25*). However, despite the benefits of increased physical activity, the percentage of children travelling by active transportation in Canada decreased by 4% between 2000 and 2010, while motorized modes of transport increased (*19*).

The decrease in bicycle usage is alarming, and several researchers found that parents have become resistant to allowing their children to cycle to school because they believe the distance is

too far or for safety reasons (*26; 27*). For example, in a recent study of the Greater Toronto Area, Mammen et al. (*26)* surveyed parents about their children's commute to school and found that only 6% of 1,016 children cycled to school. Other North American studies have found similarly low rates for bicycle usage to school such as a Utah study of adolescents by Bungum et al. (*28)* that found that of 2,692 middle and high-school students, only 1.3% of boys and 0.1% of girls used a bicycle to travel to school. In a study assessing travel to school at a national level in the United States of America, McDonald (*29)* found that bicycle usage amongst school children decreased from 1.0% to 0.8% between 1977 and 2001. These results demonstrate that a decrease in bicycle usage has consistently been reported across North America, and make clear that measures need to be taken to increase the use of this healthy and sustainable mode.

Cycling Education

One way to encourage parents and children to cycle to school is by introducing bicycle education in schools. Although in-school bicycle education programs may exist throughout North America, they are not frequently discussed in the literature, and evaluations of the effectiveness of these programs also appear to be rare. However, several examples exist such as the recent study by Hooshmand et al. (*12)* that assessed the effectiveness of a bicycle education program for 11-14 year olds in Miami-Dade County. In this study 193 students participated in a four-day off-bicycle program that taught students about bicycle safety. Based on an analysis of pre- and post-test scores, researchers found that the program was successful in increasing children's bicycle safety knowledge and subsequently expressed interest in expanding the program throughout the region. Another off-bicycle program conducted in the Pacific Northwest of the United States of America used computer-based learning to teach kindergarten to third-grade children about bicycle safety (*30*). Using random control groups, these researchers found that students who had been exposed to a bicycle-specific training program significantly improved their knowledge of bicycle safety compared to students who had not. In another study, Lachapelle, Noland and Von Hagen (*11)* investigated the pre- and post-surveys of 636 students who participated in on- and off-bicycle classes at either a summer camp or a school-based bicycle education program in New Jersey. The analysis of the surveys suggested that children's knowledge of bicycle safety improved after completing the program. Other studies in the United States have focused specifically on bicycle helmet education such as one by Ayres (*31)* that found that helmet education for children positively changed their behavior in Santa Clara County, CA, and another by Kirsch and Pullen (*32)* that concluded that two years after elementary school aged children in the Pacific Northwest had been taught about bicycle safety, including helmet use, the children continued to retain the relevant information.

This brief review of the literature has demonstrated that only a few bicycle education programs have been formally evaluated in the literature, even though, according to several authors, such programs are a cost effective way to increase safety amongst young cyclists (*11; 30*).

THE CERTIFICAT CYCLISTE AVERTI CYCLING EDUCATION PROGRAM

The CCA is a cycling education initiative for elementary schools developed by *Vélo Québec*, a cycling advocacy group that promotes cycling in the Canadian province of Quebec. The program was initiated to address the significant drop in cycling levels among children and youth in recent years in Montreal (Quebec's largest city). In addition, it serves as a response to the statistics released by the governmental branch responsible for all matters related to driving in Quebec which

showed that young cyclists are overrepresented in casualties and serious injuries resulting from road accidents (*33; 34*).

Inspired by international initiatives in cycling education such as the Belgian *Brevet du cycliste/ Fietsbrevet* (*13*), *Vélo Québec* launched its own elementary school education program aimed at children in grades five and six (ages 10-11). The CCA second year pilot project focused specifically on bicycle safety and took place in spring 2015 in five schools located in different Montreal neighbourhoods. Schools were recruited in two ways. The first was by word-of-mouth, as parents or members of the community heard about the initiative. The second was through a recruitment presentation to Physical Education teachers by *Vélo Québec*. Teachers agreed to provide feedback on the educational materials and the implementation process, to allow for improvements and adjustments to be made for future sessions of the CCA. Table 1 provides the details of the participating schools.

TABLE 1 Details of Participating Schools

Name of the school	Borough or city	Group and grade	Number of participants	Access to bicycles
Arc-en-Ciel	Plateau-Mont-Royal	1 mixed group of grade 5 and 6	22	Own bicycles
Notre-Dame-du-Foyer	Rosemont-la-Petite-Patrie	3 mixed groups of grade 5 and 6	17	Fleet of 15 bicycles loaned by the School Board
Notre-Dame-des-Neiges	Côte-des-Neiges – Notre-Dame-de-Grâce	1 group of grade 5	21	Fleet of 15 bicycles loaned by the School Board
Sainte-Louise-de-Marillac	Mercier – Hochelaga - Maisonneuve	1 group of grade 5	22	Own bicycles
Saint-Léon-de-Westmount	Westmount	3 groups of grade 5	71	Own bicycles

Preliminary meetings and planning started in early 2015, followed by half a day of teacher training at each school, during which educators were presented with the program materials and requirements. The project ran from eight to 13 weeks depending on the school, with the first groups graduating as early as late April, and the last group graduating mid-June, 2015.

The CCA program consists of four main elements. The first is comprised of six hours of off-bicycle theoretical lessons taught by the classroom teacher, focusing on road safety. The teaching materials for this phase were developed by *Vélo Québec* and reviewed by the educational councillors of one Montreal's public school boards, the *Commission scolaire de Montréal*, to ensure that it would be compatible with the other curriculum being taught (*35*). The second component of the program is comprised of six hours of practical on-bicycle lessons with the Physical Education teacher in a safe environment (gym or school yard) to develop the children's cycling abilities through games and exercises. The educational material for this phase of the program was developed by the Physical Education councillor of the school board. After the completion of the theoretical and practical lessons, the students were led by qualified *Vélo Québec*-certified cycling guides through a three to five kilometer circuit in order to experience a variety of situations and urban infrastructure specific to the neighbourhood in which their school was located. Children either used their own bicycle or one provided by the School Board. Finally, all children participated in an individual, on-road exam to evaluate their safe cycling skills. The success rates varied between schools and ranged from 23% to 65%. Students who passed the CCA program went home with a "completion of program certificate," while those who failed were given a "certificate of participation."

Several challenges had to be overcome throughout the implementation of the program such as cold and rainy weather limiting the possibilities of outdoor activities and school gymnasiums lacking space for all students to cycle at the same time. In addition, not all students had access to a well-functioning bicycle and the skill levels among students differed from beginner to advanced. Another matter was the result of the process, as several teachers felt that all students should have received a "completion of program certificate," and were disappointed by the variation of success rates in the groups. Nevertheless, the project was generally well appreciated by children, parents and teachers alike. Teachers noted that the content was relevant and well designed and that students enjoyed the program and learned many useful skills. Throughout the program, many parents expressed their appreciation of the project and wished that it would be offered more broadly in elementary schools. Several expressed that they believed that the program should be made mandatory in all Montreal elementary schools.

DATA AND METHODS

Before the beginning of the 2015 CCA program, children who would participate and their legal adult guardians were invited to take part in a survey about bicycle safety and behavior. Survey invitations were distributed to children and parents both before and after the program in order to evaluate the effectiveness of *Vélo Québec*'s program. In May of 2015, before the first session of the CCA program, classroom teachers handed out invitation letters asking students and adults to participate in the pre-CCA program survey and prizes were used as incentives. To participate in the survey, participants were directed to the online survey. Every invitation letter included a code that corresponded to both the children and the adults, and could later be used to match the parents to their children. The surveys included general questions about their cycling behavior to capture information such as their access to a bicycle and whom they generally ride with. As part of the survey, children were asked to complete a knowledge test about bicycle safety and signage that was based on the theory that would later be presented to them in class. Both children and adults were asked several attitudinal questions that assessed how much they identified with statements such as "I like riding a bicycle" and "riding a bicycle is difficult for me." Adults were also asked the same questions about their children ("My child likes riding a bicycle" and "Riding a bicycle is difficult for my child") in order to be able to analyze the difference between children's perception of themselves and adults' perceptions of their children. Several questions about individuals' motivations to use a bicycle were also included to capture the intent to use a bicycle in the future. With regard to demographic information, children were only asked to report their age and gender, while adults were asked several additional question which are presented in Table 2.

After the completion of the CCA program classroom teachers again handed out invitation letters to the children and adults. This time a post-CCA program survey was administered which tested children on their knowledge of cycling safety and asked both adults and children about their attitudes towards cycling to assess whether a change had occurred. The pre- and post-CCA program surveys were linked using a code that was included in the invitation letters that participants entered online to commence the survey.

A total of 153 children participated in the program and Table 1 includes information about the number of participants from each school. A total of 145 children and adults participated in the pre-program survey before the CCA program started, resulting in a response rate of 47.4% (145/(153*2)), and 84 participated in the post-program survey resulting in a response rate of 27.5% (84/(153*2)). After illogical responses and errors were removed, the total number of surveys used

in this analysis is 130 pre- and 75 post-program surveys demonstrating that participation rates were higher before the program (*N*=children: 80, adults: 50) than after (*N*=children: 51, adults: 24).

The following section of this paper uses qualitative measures and descriptive statistics to assess and discuss the survey findings. The results are based on a comparison of all of the children and adults who participated in the survey before the CCA program to all of those who participated after. Summary statistics are discussed and figures are used to highlight key findings and to better understand relationships between variables.

TABLE 2 Summary Statistics for Adults and Children who Participated in the Pre-CCA Program Survey

ADULTS:		
Gender Male: 35% Female: 65%	**Number of people in the household** 2 people: 16% 3 people: 14% 4 people: 49% 5 people: 18% 6 people: 2% Prefer not to answer: 2%	**Employment** Employed full-time: 61% Employed part-time: 18% Self-employed: 8% Unemployed: 8% Student: 6%
Average age 44 years old	**Number of children under the age of 16 in the household** 1 child: 24% 2 children: 59% 3 children: 10% 4 children: 4% Prefer not to answer: 4%	**Where were you raised** Montreal: 24% Another city in Quebec: 27% Another city in Canada outside of Quebec: 6% Europe: 20% Other: 24%
Education College or less: 20% Undergraduate degree: 33% Graduate degree: 43% Prefer not to answer: 2%	**Number of people in the household employed full-time** 1 person: 55% 2 people: 41% Prefer not to answer: 4%	**Did you grow up in an area that was** Urban: 39% Suburban: 22% Rural: 39%
CHILDREN:		
Gender Male: 56% Female: 44%	**Average age** 11 years old	

RESULTS

An initial analysis of the surveys demonstrates that many children and adults already used a bicycle regularly before the CCA program, knew about bicycle safety, and wanted to cycle more than they did at the time they were surveyed. After the program, however, children's knowledge about bicycle safety increased and adults' attitudes about cycling improved. The sections below use summary statistics and Chi-Square tests of independence to examine the differences in children's knowledge of bicycle safety, as well as changes in children and adults' behaviors, and attitudes before and after the CCA program.

Children – General

Ninety-three percent of the children who participated in the survey before (b) the program had access to a bicycle. This increased to 98% after (a) the program. Most children learned how to ride

a bicycle from a family member (b=79%, a=80%), although the percentage of children who stated that they learned how to ride a bicycle at school increased from 6% to 16% after the completion of the CCA program. This change was not statistically significant, indicating that many children had already been taught prior to their involvement with the CCA program. Although nearly all of the children reported that they already knew how to ride a bicycle, only 65% stated that someone had taught them about bicycle safety before their involvement with the CCA program. However, after the completion of the program this significantly increased to 96% (Figure 1). An important finding is the variation in bicycle safety knowledge learned from a family member compared to a teacher at school before and after the CCA program; although many children initially learned about safety from their parents, it is possible that some of the safety skills obtained from parents did not correspond to the actual safety rules needed to safely and confidently use a bicycle on the road.

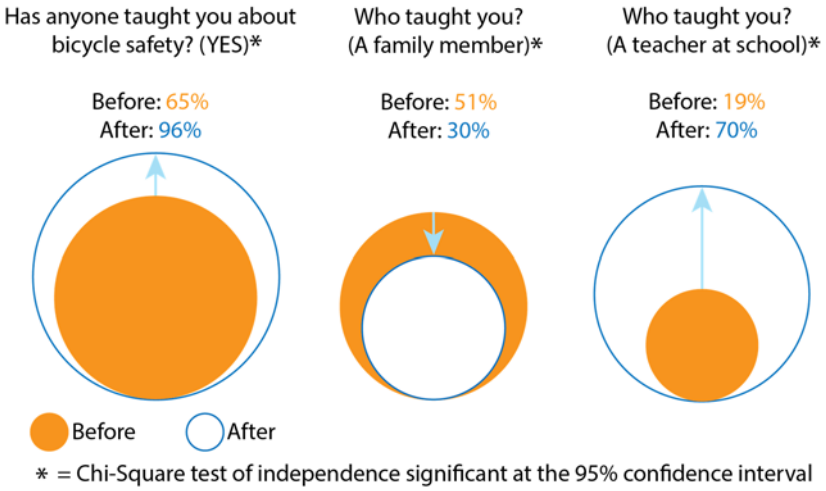

FIGURE 1: Before and after having been taught about bicycle safety

In both the pre- and post-surveys children were asked to state whether riding a bicycle to school was "not," "a little" or "a lot" like them. Whereas before the program 6% stated that riding a bicycle to school was "a lot" like them, after the program it increased to 12%. Adults' perceptions of their children were similar with 13% agreeing that riding a bicycle to school was "a lot" like their child before the program, and 29% after. Bicycle usage on the weekend increased significantly and 38% of children before the program stated that riding a bicycle was "a lot" like them and increased to 56% after. Parents' perceptions of their children's bicycle usage on the weekend similarly increased, but was not statistically significant (Figure 3).

When children were asked about cycling frequency, the question "During the spring and summer, how many days a week do you usually ride a bicycle?" yielded unexpected results. Children reported that the amount that they use a bicycle decreased after the program was completed. More specifically, fewer children reported cycling 3-5 times a week (b=45%, a=34%), and those cycling one to two days a week increased (b=25%, a=28%), as did those who cycle only a couple of times a month (b=19%, a=32%). These findings appear to conflict with those previously discussed as the statement about riding a bicycle to school and on the weekend suggest increases in ridership, but the question regarding the amount of days a week that the children cycle suggests a decrease. These seemingly contradictory findings may be a result of the wording of the questions having been confusing for children, or could signify that while actual ridership did not increase, children began to self-identify more as cyclists.

Children's Bicycle Safety Knowledge

The primary purpose of the CCA program is to teach children how to become safer cyclists. Based on an analysis of the pre- and post- surveys it is clear that the program was successful in increasing children's theoretical knowledge of bicycle safety. Figure 2 demonstrates several sample questions that were included in the pre- and post-knowledge tests and demonstrates how the students preformed before and after the completion of the CCA program. Children improved their knowledge of overall bicycle safety, and especially hand signals. The results of the pre- and post-tests also demonstrate that children learned the value of communicating with other road users. More specifically, while before the program 55% stated that the reason that it is important to make visual contact with drivers is to make sure that the cyclist's intentions are understood, after the program this response significantly increased to 88%.

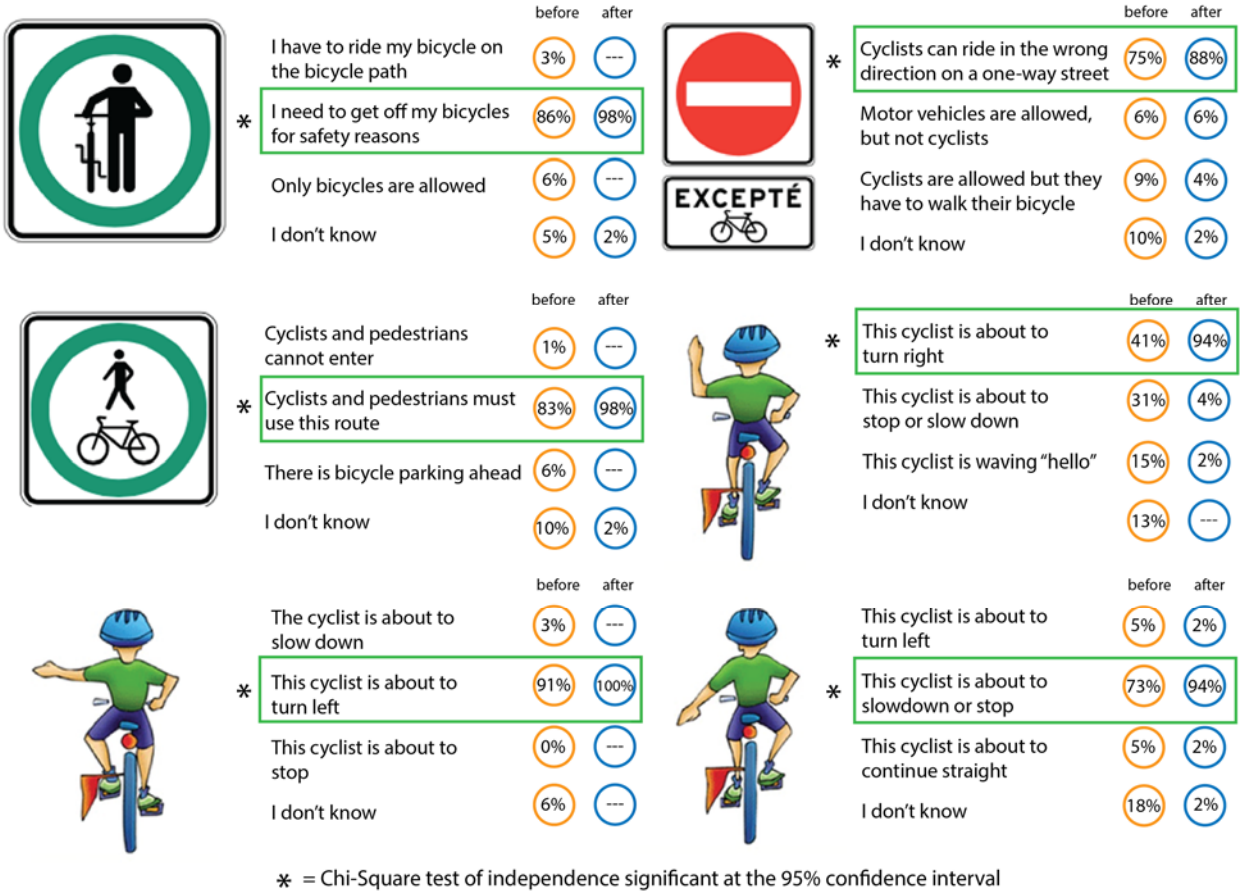

FIGURE 2: Sample questions from the children's bicycle safety knowledge test.

The statistically significant improvements between children's pre- and post-test scores demonstrate that the CCA program was effective in improving children's theoretical knowledge of bicycle safety. However, because the pre- and post-tests were administered within four to six weeks of each other, memory retention may have been better in the short-term, than it would be if the test had been administered after a longer period of time. Therefore, a more robust study would include the results of a follow-up study approximately a year later as suggested by Lachapelle, Noland and Von Hagen (*11*). In addition, it is not certain that students who improved their

theoretical knowledge of bicycle safety also put their skills into practice on the road. Therefore, in an attempt to capture changes in students' on-road cycling behavior, the following section analyses students' self-reported behavior both before and after the CCA program. Next, parents' perceptions of their children are analyzed as a control for children overestimating their abilities as cyclists.

Children's Behavior and Attitudes

The survey tested children's perceptions of their behavior before and after the CCA program. Using a three-point Likert scale, questions asked the children to choose whether statements were "not like me," "a little like me," "a lot like me," or "does not apply." An analysis of children's pre- and post-CCA program responses suggests that the theoretical and practical classes increased the children's skills and confidence as cyclists. For example, before the theoretical and practical classes 75% of children stated that riding a bicycle was not difficult for them, which significantly increased to 92% after they completed the program.

The same Likert scale as mentioned above was used to assess whether children put the theory that they learned into practice, and the results are presented in figure 3. Based on these findings, it is unsurprising that after the completion of the program, 72% of children stated that the bicycle classes at their school made them a better cyclist, 62% felt more comfortable riding a bicycle than they did before the program, and 52% believed that they would use a bicycle more often after they completed the course. Because the students' self-evaluation of their bicycle habits were aligned with the results of the pre- and post-knowledge tests discussed above, it can be concluded that the CCA program motivated children to become safer and more responsible cyclists.

Adult's Perceptions of Children

In order to control for children potentially over-estimating their own abilities (*36*), both the pre- and post- tests evaluated parents' perceptions of their children using the same questions that were included in the children's version of the survey. For example, when adults evaluated their children before the CCA program, 62% stated that riding a bicycle was not difficult for their child. After the program, parents' perceptions of their children increased significantly with 92% stating that riding was not difficult for their child. Figure 3 demonstrates the differences between the children's self-evaluations and the parents' evaluations of their children for various statements about bicycle safety and habits. Although, children might be over-estimating or parents under-estimating their cycling habits, differences are clearly observed after the CCA program. The first and second columns of Figure 3 demonstrate the differences between children's perceptions of their own cycling habits before and after the program compared to parents' perceptions of their children. The final column in the figure represents adults' perceptions of their own cycling habits. The evaluation of both children's self-perception and adults' perceptions of their children, as well as the statistically significant results of the post-knowledge test demonstrate that the CCA program was effective in teaching children to safely use hand signals on the road, and increase their confidence as city-cyclists.

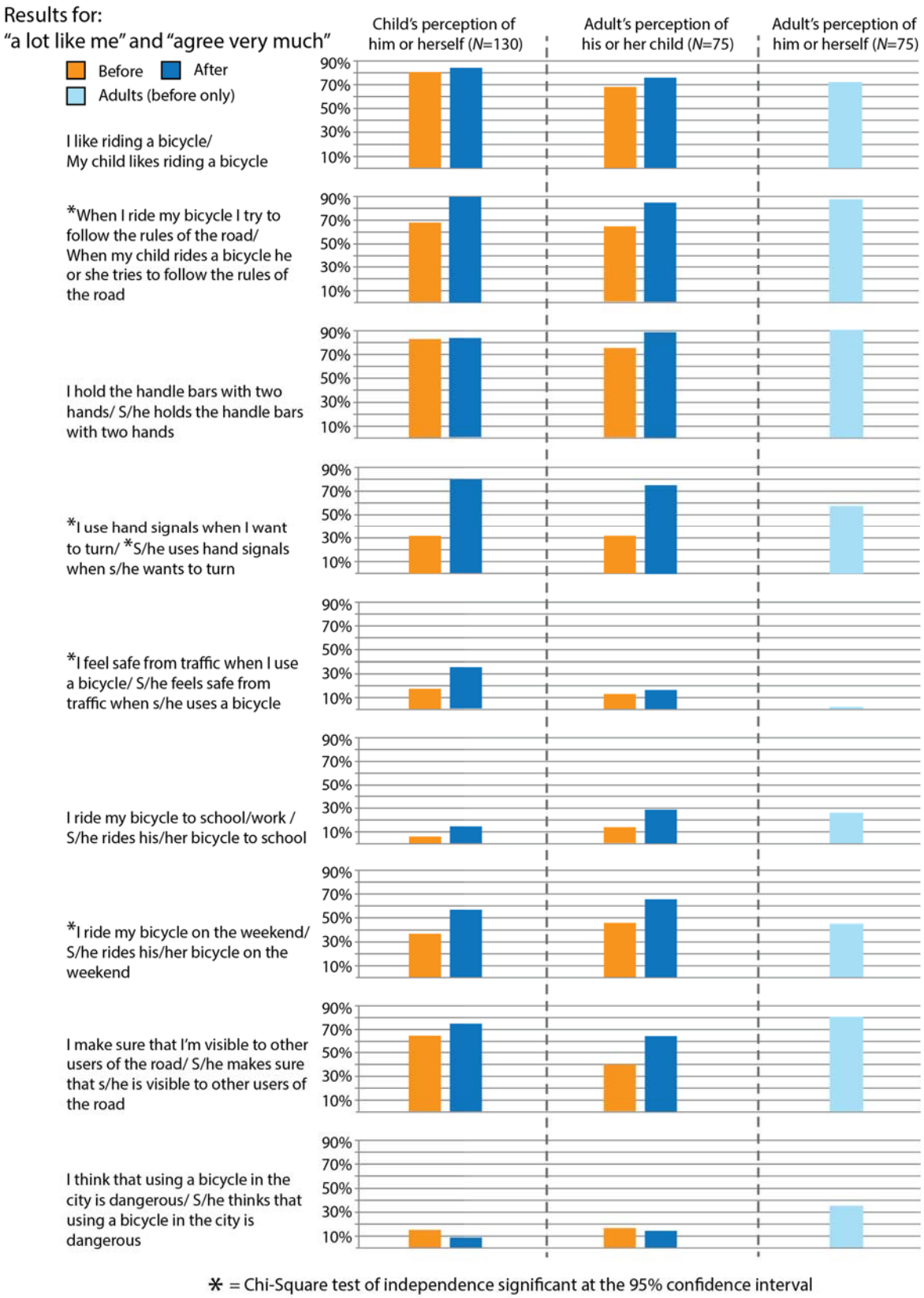

FIGURE 3: Perceptions of cycling habits and skills.

Adults' Behavior and Attitudes

While the results of the analysis above have made clear that the CCA program positively influenced the skills and attitudes of young cyclists, this section aims to evaluate whether the behaviors and attitudes of the parents of whose children participated in the CCA program were also influenced by the program.

Nearly all of the adults in this study stated that they know how to ride a bicycle (94%). However, only 75% reported that they have access to a bicycle. Most of the adults who own a bicycle use it alone (63%), but many also cycle with their school-aged children (58%) or with other family members or friends (26%). More than half of the adults ride a bicycle at least once a week during the spring and summer, and 25% reported that they use a bicycle five or more days a week. Despite the already high usage, most adults want to use a bicycle more than they currently do (86%), and also would like their children to increase their bicycle usage (92%) (Figure 4).

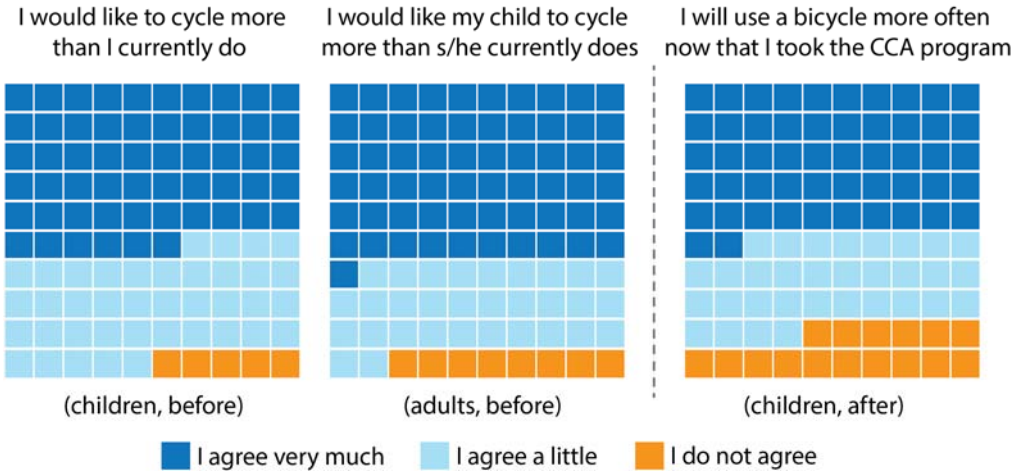

FIGURE 4: Desire to use a bicycle.

When adults were asked whether their child rides a bicycle to school when the weather allows, there was a significant change between before (22%) and after (46%) the CCA program. However, these results do not align with those discussed earlier, as children reported that the amount that they use a bicycle decreased after the CCA program and neither the children's nor the parents' opinions about using a bicycle to get to school increased significantly as was shown in figure 3. These conflicting results raise the question of whether asking parents about children's travel behavior is reliable, and future studies would likely be better off assessing cycling frequency in children through the use of a global positioning system (GPS) unit (*37*). However, the finding that before the program 92% of parents and 95% of children stated they agreed "very much" or "a little" with wanting (their children) to cycle more, but after the completion of the program only 84% of children said that they agreed "very much" or "a little" that they believed that they would increase their frequency of bicycle usage, suggests that there is a disconnect between the desire to use a bicycle and actually doing so. This means that 11% would either like to cycle more, but do not think they will, or alternatively, these results could signify that 11% of children became discouraged to use a bicycle after the CCA program. However, since the overall comments about the program were very positive and there was an increase in children stating that they like using a bicycle, it is more likely that children are experiencing a barrier to using the mode.

When we asked parents to state the main reason that they do not allow their children cycle to school they reported that it is because they are worried about their children's safety with regard to traffic (37%), the volume of traffic between their home location and the school (22%), and the concern that their child's bicycle might be stolen (20%). These results demonstrate that bicycle education is equally important as making improvements to bicycling infrastructure as both are necessary to motivate safe cycling behavior and thereby prevent injury (*12*).

When adults were asked whether they had changed their cycling habits or perceptions since their child completed the CCA program, 50% reported that they had. Those who responded positively were asked how their habits or perceptions had changed. Responses that demonstrated that adults' perceptions had changed were primarily concerning increased confidence in children. For example one parent responded by stating *"I'm more confident to let my daughter ride her bike alone. She knows the rules well, and has passed them on to us. [translation from French by author]."* Another parent expressed an increase in confidence by stating, *"Now I no longer believe that this mode of transport is dangerous for children [translation from French by author]."*

Other changes in behavior had to do with parents wanting to set a good example for their children. One parent stated *"I pay more attention to the rules of the road: stops, signaling, who has priority, especially when I cycle with my child, to set a good example [translated from French by author],"* while another reported, *"Now I know that my child knows the right rules so I do not want to contaminate him with my bad habits [translated from French by author]."* In addition, adults also stated that their own cycling habits became safer and one parent made the comment, *"I now cycle on the road rather than the sidewalk [translated from French by author],"* while another conveyed, *"I now wear a helmet for safety reasons [translated from French by author]."*

These changes in attitudes and behavior demonstrate that the CCA program not only benefited the children, but also changed the habits of the adults who interacted with the children. Previous research in other fields has shown that children have an influence on their parents (*15*), and research on health education in children found that a school program teaching grade three to five students with asthma about self-management skills positively influenced their parents behavior (*16*). Parents' changes in cycling behavior after the CCA program demonstrate a similar effect.

DISCUSSION & POLICY RECOMMENDATIONS

The analysis of children and adults' pre- and post-surveys suggest that the CCA program was successful in teaching children about bicycle safety and improving both groups' attitudes towards using bicycles as a mode of transportation. The research approach of testing children's theoretical knowledge about road safety, their self-perception as cyclists, as well as the parents' perceptions of their children enabled us to analyze children's behaviors from different angles, and therefore, confirm that the CCA program was successful in teaching children about bicycle safety and changing adults' attitudes in the short-term. Figure 5 demonstrates that both adults and children found that the CCA program positively influenced the children's abilities to use a bicycle.

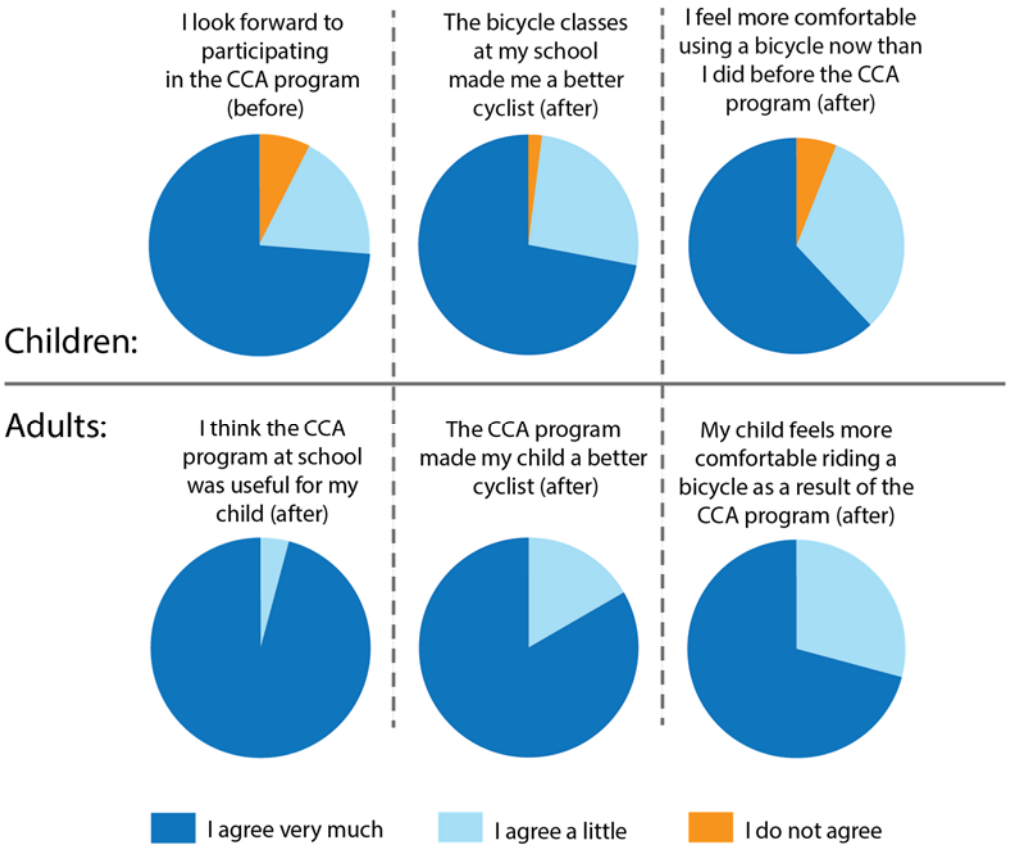

FIGURE 5: Assessment of the CCA program.

Although after the completion of the CCA program, the children became better cyclists, and half of the adults changed their perceptions and/or cycling-related behavior, a disappointing finding of the study is that children did not report significant increases in using a bicycle to get to school. This result makes clear that even though school bicycle education programs can have a positive influence on both the participating children and their parents, without sufficient bicycle-specific infrastructure, behavioral changes are unlikely to occur. As mentioned earlier, the main reasons that parents resist allowing their children to use a bicycle to get to school is because they are worried about their children's safety with regard to traffic (37%), the volume of traffic between their home location and the school (22%), and the concern that their child's bicycle might be stolen (20%). Therefore, even though 24% of parents stated that they moved to their current home location because they wanted to live in a neighborhood where their children could walk or cycle to school, and 6% wanted to be in a bicycle-friendly neighborhood, without infrastructure that can support the safety of young cyclists, the bicycle mode share to school is unlikely to increase. Therefore, policies that promote the development of bicycle-specific infrastructure should be implemented, especially near to schools. In addition, when parents were asked whether their current neighborhood was very or extremely bicycle friendly, only 20% agreed, with 53% stating that it is moderately bicycle-friendly, and 28% stating that it is only slightly, or not at all bicycle friendly. These results demonstrate that there is a disconnect between the desire to use a bicycle, and how the urban environment influences mode choice (*38; 39*).

One approach to making cycling to school safer in the short-term is by developing "cycle-to-school" programs where an adult would pick up children by bicycle on the way to school similarly to a school bus. Although such a program would only be safe in neighborhoods with

bicycle-friendly infrastructure, it is one way to increase cycling amongst children. When parents were asked whether they would allow their children to participate in an organized "cycle-to-school" program, most responded positively with 55% stating yes, 33% stating maybe, and only 12% stating no. Because many of the children who participated in the CCA program stated they would like to cycle more, and parents reported that they would like their children to cycle more (Figure 4), the development of a "cycle-to-school" program could be an effective way to increase ridership amongst school-aged children in Montreal. Therefore, bicycle advocacy groups and schools should work together to develop such programs with the goal of increasing cycling not only in Montreal, but across Canada.

LIMITATIONS AND FUTURE RESEARCH

It is important to note that this study assessed children's knowledge of bicycle safety, and adults and children's perceptions and behavior in the short-term, but it was beyond the scope of this study to determine the long-term effects of the CCA program. If this program were to be repeated in future years, it would be beneficial to assess the behavior of graduates from the CCA program a year after the completion of the program or even several years after. Another limitation of this study is the lower post-survey response rate. In the future, changes in the data collection methods should attempt to motivate all pre-survey participants to also complete the post-survey. Finally, future studies should consider using GPS units to track children's travel behavior as the results of this study raised questions about the reliability of adults' reports of their children's travel habits as well as children's self-reported travel behavior.

CONCLUDING REMARKS

The results of this study have made clear that off- and on-bicycle school-based education about bicycle safety is one way to effectively teach children how to become responsible, safe, and confident cyclists. In addition, the results demonstrated that a byproduct of teaching school-aged children about bicycle safety is that the children's parents are also likely to change their cycling behavior and attitudes towards using a bicycle. An analysis of the parents' comments of the program in general revealed that many were very enthusiastic about the CCA program, and several commented that it should become a mandatory aspect of elementary education. For example, one parent stated that *"[t]his is an essential course that should be part of the elementary school curriculum [translation from French by author]."*

This research, based on surveys of children and their parents or legal guardians/tutors who participated in a bicycle education program for school-aged children in Montreal, Canada, provides new insight into cycling education. The findings can be useful for school boards and bicycle educators to better develop and assess bicycle education programs in the future, as well as for planners and policy makers to understand the aspects that influence bicycle use to school. Policies that encourage bicycle education and the development of neighborhoods that promote cycling will not only reduce costly traffic congestion and emissions, but will also contribute to increasing active and healthier lifestyles for children and adults.

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