Young children's safety understanding and behaviour in traffic situations.

Valdimar Briem and Hans Bengtsson
Department of Psychology, University of Lund,
Paradisgatan 5P, 223 50 Lund, Sweden

Abstract: 45 children (3:6-6:9) were observed in 2 traffic situations, (a) a traffic model, where they used dolls to enact the movements of two children on the way to and from day-care, and (b) as they crossed a lightly trafficked, minor road in a situation analogous to that in the model. Special attention was given to road-crossing behaviour, seen here as a task consisting of 3 components, (i) using a zebra crossing, (ii) stopping at the curb, and (iii) looking for cars. The results showed that the children's performance on the 3 components was differentially related to their safety knowledge and understanding. Age and understanding were shown to be important predictors of the ability behave appropriately in both traffic situations. In the model, correct behaviour was shown more often in the use of the zebra crossing than in stopping and looking for cars, while the opposite was true for the roadside situation.

1 Introduction

Available research concerning the ways in which young children cope with risky situations encountered in traffic is at the present time fairly limited. We lack, for instance, concrete information about the relation between children's knowledge and ability to reason correctly about the traffic and their behaviour in traffic environments (cf. Vinjé, 1981), the ways in which children conceptualise risky situations, and how their concepts of risk and safety influence their behaviour. All in all, the role played by cognitive factors in young children's ability to cope with dangerous environments, such as the traffic, is still a relatively under-researched area.

The conclusion of most studies of young children's contact with traffic is that they cannot be expected to be able to cope with the complex situations and decisions encountered in this environment (Rothengatter, 1981; van der Molen, 1981; Vinje, 1981; Phinney, Colker, & Cosgrove, 1985; Briem, 1988; Ampofo-Boateng & Thomson, 1991). Some putatively causal factors highlighted here are cognitive in nature, such as e.g. the children's attention, judgements of safety and risk, and perception of relevant spatial and situational attributes. Results from the available studies of these factors indicate that, compared with older children and adults, young children have relatively little control over their attention and momentary impulses, are less adept at localising sound, have a narrower visual field, as well as a difficulty attending to several aspects of the traffic situation at the same time, and are poor judges of the speed of oncoming vehicles (Sandels, 1970; Salvatore, 1973; Pfeffer & Barnecutt, 1996). We can conclude that, because of these cognitive limitations, young children are at considerable risk in many traffic situations.

Kail (1990) has proposed that the development during childhood of several, important, cognitive functions mirrors the development of an underlying information processing

mechanism. In support of this hypothesis, Kail provided material from a number of his own studies, which demonstrates that the processing time in a variety of cognitive tasks, given to groups of children of different ages, decreases as a function of the children's age. This indicates that young children's attention and memory capacity is fairly limited, and only begins to approach adult level in the early teens. One effect of this might be that young children are only able to deal effectively with a single or a limited number of aspects of any given situation at a time. In a dangerous environment, such as traffic, where quick decisions have to be made between several important possibilities in the situation and tasks to be performed, a wrong decision may have serious, or even fatal, consequences.

Some of the behaviour that takes place in traffic situations may be characterised as the following of some rule or other, but these are usually taken for granted, and only a few of them are explicitly defined, such as, e.g., the *"Green Cross Code"*. The development of these rules may be taken to be analogous to that of any other rules. Siegler (1978, 1981) studied the way young children use rules when solving problems, and proposed that children do not begin to develop a rule-governed approach to problem solving until about the age of five. To begin with, the rules used are simple, but are replaced later on in the children's development by sophisticated rules that take into account more complex aspects of the problem situation (cf. also Case, Marini et al., 1986; Zelago & Shultz, 1989). There is no reason why we should not expect to find a similar development in children's ability to follow rules in traffic. This increased ability would most likely also entail a more general understanding of risk and safety.

It may seem reasonable to suppose that a child who *knows* that it is dangerous to step into the road in front of an oncoming car is less liable to do so than a child that does not know this. Ryle (1949) proposed that there are two distinct kinds of knowledge that a person may possess, and he referred to these as *Knowing How* and *Knowing That*. In psychology, these are sometimes referred to as *Procedural* and *Factual knowledge*, respectively. This does not refer to the difference between knowing facts, such as *cars are made of metal* or *the road is 10 meters wide*, and knowing how to describe procedures (or *rules* or *scripts*), such as *when you cross the road you must stop, look left, right and left again, and cross if all is clear*. The difference is between knowing facts and rules, explicitly formulated in words, and knowledge that is shown in action, referred to as *"skills"* (Ryle, p. 30). A young child may possess many different items of knowledge, relevant to safety in a traffic situation. This knowledge would be both factual, like knowing that such and such a thing *is* a reflector, and procedural, like knowing that you must pin a reflector onto your coat when it is dark, and skills, like riding a bicycle or pinning the reflector on before going out.

But the child may or may not be able to associate these different kinds of knowledge to each other in a real traffic situation. The child may know a certain thing to be a car and this thing to be "dangerous", but may not be able to place it conceptually in the class of things adults refer to as "vehicles". Then, standing at the side of the road, and seeing some unknown vehicle coming along the road, the child may not realise that this thing is equally dangerous as a "car". Also, the child may know exactly what its mother said about it being dangerous to walk across if there were cars nearby, that the child should stop at the curb, and look carefully before crossing. The child, following the mother's instructions carefully, stops at the curb, waits, looks around, left, right, left again, and then confidently steps into the road, in front of the oncoming vehicle (cf. Sandels, 1974).

What is lacking in situations such as these that makes the knowledgeable young child so vulnerable? The child knows about the danger, and follows the procedures laid down for crossing, but is still at risk. The young child may, in fact, possess any amount of items of both factual and procedural knowledge, as well as the appropriate skills, but still not be able to apply them properly when they are really needed. What seems to be missing is a *proper understanding* of what a dangerous situation involves.

The definition of "understanding" offered here is stricly operational. It refers to the *ability*, given the possession of the relevant factual information and skills, to perform an appropriate action when needed. A "proper understanding" in the present context then refers to a child's ability to avoid dangers encountered in traffic, as a consequence of possessing the relevant knowledge, as well as being able to apply it appropriately and explain it satisfactorily when needed. Then it is essential for the young child both to know (i) what are *risky situations*, (ii) what the possible *actions* in such situations are, (iii) to have the knowledge to select and guide the *appropriate* actions, and (iv) to possess the necessary *skills* to perform these actions.

We have set up two simple models (Figure 1, a and b) in order to describe how the understanding of safe behaviour may be mediated. According to the first, correct behaviour is completely based on a proper understanding of what to do in dangerous situations generally, situational knowledge in this case being of minimal significance; the behaviour in both simulated and real traffic situations would then essentially be the same. According to the second model, correct behaviour is learnt properly in the stuation where it is to be applied, and the behaviour seen in two different, but analogous, situations will be significantly different. But rather then accepting either of these two extreme models, we propose that a combination is a more appropriate way of viewing the relation between cognitive factors and behaviour (Figure 1 c). According to this view, a child's behavioural skills are learnt in many different situations. Each of these has its own, salient specifics, and the child is liable to act according to those in the given situation. As the child develops and attains more knowledge, it becomes better able to see similarities and differences between situations, and to select optimal strategies to deal with the particular situation at hand. Thus, a battery of relevant instances is created, where any new situation may be found to have a counterpart. A substantial part of the child's competence then consists in being able to cognitively apply old procedures to new situations, making possible flexibility of choice and generality of application.

When the performance of young children is brought into a developmental perspective, it is at times difficult to separate cognitive growth from repeated exposure to and practice in the tasks in question. In order to test this we propose to compare young children's performance to the their knowledge and understanding at different ages. We want to assess the quality of the children's answers to questions designed to uncover the understanding of their own actions, and relate this to their actual application of behavioural skills in the relevant situations. In this way, the cognitive strands may (hopefully) be unravelled and distinguished from those stemming from practice in the task.

With respect to the tasks employed for this purpose, we observe the children's traffic behaviour in two analogous situations, where they (i) demonstrate in a model situation how some other skilful individuals perform, and (ii) how they themselves perform the same task in real traffic. We then examine how the behaviour in both situations corresponds. In accor-

dance with model (c) we propose that there will be an underlying similarity in the way the children tackle the two situations, mirroring their basic understanding of the situations and skills involved. But there will also be a considerable difference in performance due to the children's perception of the two situations and their differential requrements. In this way we hope to learn more about how young children cognitively represent potentially dangerous situations, and how this corresponds to what they actually do in these situations.

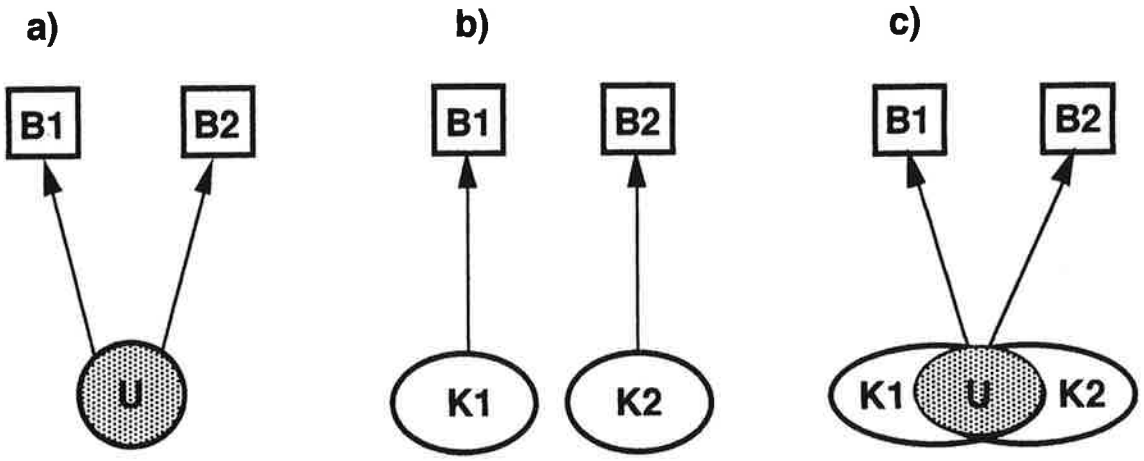

Figure 1. Three models of how a child's situational knowledge (K) and understanding (U) may be related to behavioural skills (B). a) The child's understanding decides entirely how it behaves in two different situations that require analogous behavioural skills. b) The child's knowledge of each of the two situations decides how it will behave, while understanding does not directly affect the behaviour. c) The behaviour in the two situations is the result of both an understanding of how to behave and the specific knowledge of the situations.

2 Method

Subjects. 45 children, 3:6-6:9 years, attending day-care centres in the towns of Halmstad and Lund in the southwest of Sweden, participated in the study. The distributions according to age and sex are shown in Table 1.

Table 1. Observed frequencies for age group and sex for the children in the study.

	Three/Four	Five	Six	Totals
Girl	8	8	5	21
Boy	4	7	13	24
Totals	12	15	18	45

Material. In one part of the study, a *traffic model* made from stiff cardboard, 120 cm X 150 cm, was used (see Figure 2). It contained 3 roads with pavements, 2 crossings with road signs, 3 houses surrounded by lawns and bushes, and a pond. One of the houses was a

day-care centre. There were 2 cars and 3 dolls, representing 2 child pedestrians and 1 cyclist. The set-up and objects in the model were associated to a story about two children, Kalle and Kajsa, and their journey to and from the day-care centre. Other actors in the drama were the child cyclist and the two cars. Kalle and Kajsa and the cyclist were each embodied by the dolls, whose heads could be turned from side to side. The doll representing the focal child wore a small reflector, and the doll on the bicycle wore a helmet.

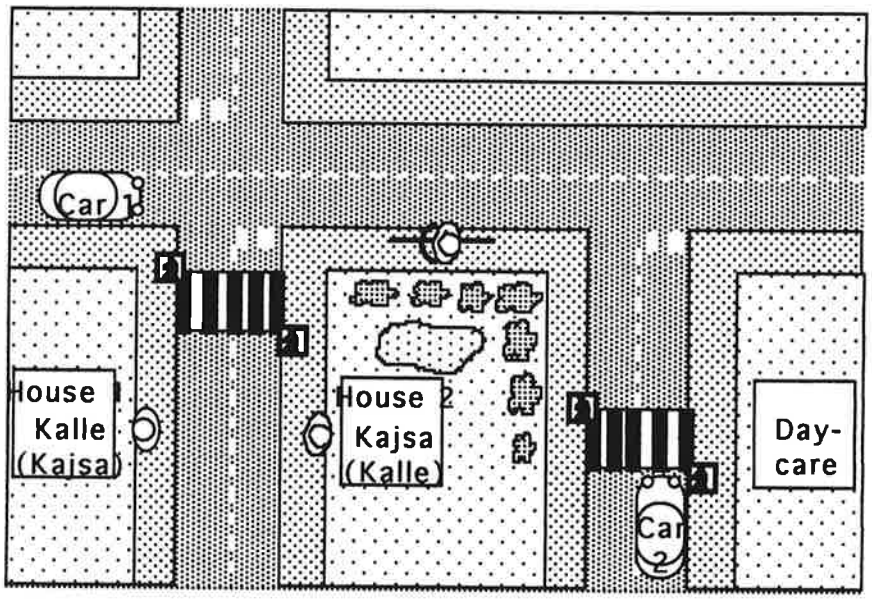

Figure 2. A schematic picture of the traffic model used in the study. The figure shows the initial set-up of the model and the dolls.

Variables. There were two grouping variables, *Age group* (Three/four, Five, Six) and *Sex* (Boy, Girl). Chronological age (continuous variable) was also used in several of the statistical tests. *Safety knowledge and understanding* wer, firstly, assessed in the answers to 4 questions, concerning the function of (i) the *Reflector* and (ii) the bicycle *Helmet*, (iii) understanding of the instruction to be *Careful*, and (iv) the *Explanation* (after crossing Road 1 the first and second time) of why they chose or chose not to cross the road on the zebra crossing. Dependent variables concerned the children's *road crossing behaviour*, represented in three behaviour indices, (i) use of a zebra crossing, (ii) looking for cars, and (iii) waiting at the curb, and were recorded in the model situation as *ZebraM*, *LooksM*, and *WaitsM*, and in the roadside situation as *ZebraR*, *LooksR* (*Waits* was not recorded at the roadside). For the purposes of a final repeated measures ANOVA, we made 2 compacted variables, combining *ZebraM* and *ZebraR* in *Zebra Crossing*, and *LooksM* and *LooksR* in *Looking*. Knowledge of *Road signs* was also included as a fifth knowledge variable here.

Variable coding and transformation: a) The children's answers to the four questions connected with the story were rated as to degree of understanding of the nature and function of the things asked about, and coded as continuous variables (range 0-2): 0 (= *Don't know*) = not knowing or not answering, showing a lack of understanding of the point of the question or giving an egocentric answer; 1 (= *Pre-safety*) = showing incomplete understanding of the point, such as saying that the function of the reflector was to *see* better in the dark, or that of the helmet not to *fall off* the bicycle; 2 (= *Safety*) = showing an understanding both of the

relevance of the question, and of the function of the item or behaviour for personal safety in the traffic situation. b) Road-crossing behaviour in the model was recorded at four points during the journey, when crossing the 2 roads, going *to* and returning *from* the day-care. At each point, three task components were recorded, (i) using /not using the zebra crossing, (ii) waiting/not waiting before crossing the road, and (iii) looking/not looking for cars before crossing. *ZebraM*, *LooksM*, and *WaitsM* were obtained by summing the scores obtained on the 4 crossings. At the roadside, *ZebraR* and *LooksR* were obtained by summing over 3 crossings, making a simple transformation of the latter scores necessary for the variables in both situations to have the same proportional weight.

Procedure. **(1)** In the *traffic model* situation, each child was tested individually by two experimenters at the child's day-care centre. The child was told a story about a child (*Kalle* or *Kajsa*), his/her own age and sex, who goes to the day-care centre with a friend of the other sex (*Kajsa* or *Kalle*) who lives in the house opposite. The child was asked to move Kajsa and Kalle to various destinations in the model as the story progressed, requiring him/her to let the dolls cross the roads. This gave the child an opportunity to demonstrate his/her understanding of traffic devices and rules and of safety behaviour. The child was continually asked questions related to the story, designed to extract further information about knowledge and reasons for acting in particular ways. After the observation in the model, the children's knowledge of 6 road signs, (i) Zebra crossing, (ii) Stop, (iii) Pedestrian lane, (iv) Bicycle lane, (v) No walkin, and (vi) No Cycling, was tested.

(2) In the *roadside* situation (real traffic), the children's behaviour was video-filmed when crossing a lightly trafficked road near the children's day-care centre. The crossing situation, shown in Figure 3, was chosen so as to be analogous to that in the model. The children were accompanied singly to a place near a zebra crossing with an unobstructed view of on-coming traffic in all directions, including the road past the T-junction (2). One experimenter stayed with the child the whole time, giving instructions about what to do, and seeing to it that the child did not run around on its own when there were cars near by. The other experimenter operated the video-camera, and recorded the sequence of events.

The child's task was to cross the road, from the point marked "X" in the diagram, about 15 meters from the zebra crossing, to a tree on the other side of the road. Each child had previously been tested in the model situation and instructed in the importance of following traffic rules. Apart from that, no further instructions were given at the time of observation as to how to cross the road. After crossing and arriving at the tree, the child was told to go back to the point where he/she had started from (X), whereafter the child was told to go to the tree on the other side once again. Thus, each of the children crossed the road three times, and normally the whole procedure took less than 5 minutes. After that the child was taken back to the day-care, and the next child accompanied to the scene of observation. The videofilms were subsequently coded and analysed.

3 Results

Statistical tests were done in *StatView* (Haycock, Roth, and Gagnon, 1993), *SuperANOVA* (Gagnon, Roth et al., 1991), and *SPSS* (SPSS, 1995). The significance level was set at 0.05.

(a) *Understanding of traffic safety and devices.* First we did a MANOVA with *Explanation*, *Careful*, *Reflector*, and *Helmet* as dependent variables, and *Age group* and *Sex* as independent variables. The results were significant with respect to *Age group* (Hotelling-Lawley Trace (8,66) = 0.74, F=3.0, p=0.008), but not *Sex* (Hotelling-Lawley Trace (4, 33)= 0.20, F=1.6, p=0.186). In the 4 2-factor ANOVAs, there was a clearly significant age effect only for *Explanation* and *Reflector* (F(2,36)=7.1, p=0.003 and F(2,36)=6.3, p=0.005, respectively).

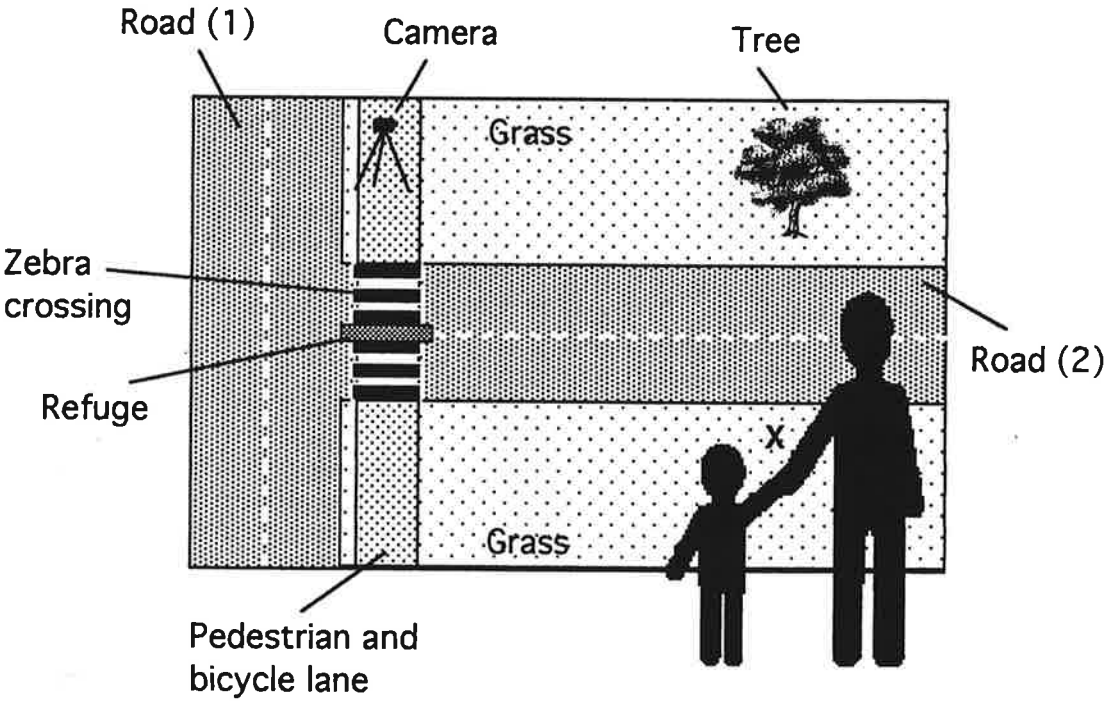

Figure 3. A schematic view of the roadside traffic situation used in the study. The figure shows the initial set-up of the child and assistant. The staring point is marked "**X**".

(b) *Understanding in relation to behaviour in model and at roadside.* Next we subjected all the variables used, the 5 variables concerned with knowledge and understanding and the 5 behaviour variables, to a Pearson correlation, and the results of this to a factor analysis. The best factor solution was with 3 factors, as shown in Table 2.

(c) *Behaviour in traffic situations.* Finally we examined the relation of the children's age to the behaviour variables recorded in the two traffic situations, model and roadside. This was done in 2 separate, repeated measures ANOVAs. A significant difference was found for both kinds of behaviour with respect to *Age group*, with F(2,33)=8.0, p=0.001, with respect to the use of a *Zebra Crossing*, and F(2,32)=6.4, p=0.019, with respect to *Looking* for cars. Use of a zebra crossing was significantly different in the model and at roadside (F(1,33)=63.9, p<0.001), the children using the crossing far more often in the model than at the roadside. Looking around for cars was also significantly different for the two traffic situations (F(1,30)=2.8, p= 0.106), but here the relation was the reverse, with the children looking for cars about twice as often at the roadside as in the model. The mean behavioural scores with respect to age group and behaviour are shown in Figure 6.

Table 2. Exploratory factor analysis of age and ten behavioural and knowledge items, resulting in three main factors (**F1-3**). Factor loadings >.4 are shown.

	Factor 1	Factor 2	Factor 3
Age		,451	,647
Explanation	,939		
Careful		,542	
Reflector			,664
Helmet			,855
ZebraM	,468		,547
WaitM		,936	
LookM		,835	
ZebraR	,473		
LookR		,605	
Signs	,646		,538

Orthogonal Solution

F1: The better the ability to explain the function of the Zebra crossing (and knowledge of road signs), the bigger the probability of crossing the road on the zebra crossing both in model and at roadside.

F2: The greater the age of the child, and the better the ability to explain the meaning of the need to be careful, the bigger the probability of waiting and looking before crossing the road, both in model and at roadside.

F3: The greater the age of the child, and the better the ability to explain the use of safety devices and road signs, the bigger the probability of crossing the road on the zebra crossing in the model.

Figure 4. The children's behaviour in the two traffic situations as dependent on their age. S.E. is shown for each mean score.

4 Discusson

The single most significant determinant of safety knowledge, understanding, and behaviour in the model was found here to be the children's age. We begin by summing up the results from the testing in the model situation with respect to this factor:

Most of the 3/4-year olds had at least a vague understanding that road traffic posed a potential danger to the dolls, they occasionally used a zebra crossing, but seldom looked around or waited before crossing. The majority of the children in this age group did not know why one should use the crossing, but frequently responded with "I don't know", or gave some irrelevant answer, such as "because I wanted to". The children in this youngest group generally did not know why they ought to wear a reflector when walking outside after dark, and while most had an idea that the helmet provided some sort of protection when cycling, they were unsure of why this was so.

The 5-year olds had a clearer conception of the dangers of the traffic, and that danger requires that one adopt certain safety measures. They sometimes let the dolls use the zebra crossings, but looked around for traffic only about half the time, and many of the children in this age group had a problem verbalising an appropriate reason for doing so. More than half of the 5-year olds believed that they could see better in the dark if they had a reflector, and many thought that the helmet was a safeguard against falling off the bicycle.

By the age of six, the children had managed to overcome many of the limitations in understanding demonstrated by the 5-year olds. They no longer believed that the helmet protected them from falling off the bike, and they generally differentiated between falling off and getting hurt. They usually understood that the function of the reflector is coupled to how one appears oneself from the point of view of the car drivers. Generally, the 6-year olds did not understand the reciprocity of communication between participants in the traffic situation at the zebra crossing, and often forgot to let the doll look around when crossing the road.

When we compare the children's behaviour in the model to that in the analogous, real traffic situation at the roadside, we can see both similarities and differences. A major difference was that the children used the zebra crossing in the model far more often than in the real traffic situation. This may have resulted from the differences in the physical structure of the two situations, which naturally was considerable. In the model, the children had a clear view of two well defined zebra crossings, but while the zebra crossing at the roadside was clearly visible, it was also much farther off and in the periphery of the children's visual field at the time when they received the instructions as to what to do.

A clear difference between the two traffic situations was also shown in the tendency to look around before crossing the road. Here, the opposite tendency was shown compared to that for the zebra crossing, as the children looked around for traffic cnsiderably more often at the roadside than in the model situation. There are two possible explanations for this: In the first place, the result may be taken to imply that the looking-around at the roadside is partly an automatic reaction to a situation that the child has been in many times before. Alternatively, the explanation may be that the real situation contains cues that makes the children conscious of the need to look for traffic before crossing the road, cues that are not

available to the same extent in the model situation. It is clear that the factors that decide the quality of the child's behaviour in such situations merit a closer study.

The differences in behaviour that the children displayed in the model and real traffic situations indicate the importance of context for young children's behaviour. The correlations between the analogous behaviour in the two contexts were fairly small, especially for the tendency to use a zebra crossing. However, the factor analysis reveals that analogous behaviour in both test situations is linked together in the factors obtained. One of these includes the children's proper understanding of the need to be careful, and another factor includes the understanding of the need to use a safe place to cross the road, *viz.* the zebra crossing. This dawning understanding of traffic safety forms a foundation on which the children are later able to build a more solid understanding, making it possible for them to accommodate their behaviour to a variety of contexts in a flexible and functional way.

It is obvious from the present results that, at this age, children are not capable of dealing adequately with the complexities of risky situations such as the traffic, and also that their behavioural skills generally do not match what to adults may seem to be a reasonable understanding of risk, safety, and traffic rules. Important components, necessary for dealing with dangerous situations, are missing, both from the children's knowledge and from their behavioural repertoire. Also, it appears that young children's skills, in this case for behaving appropriately in traffic, are to a considerable extent specific to the situation in which they were learned, and the children are not able to integrate their knowldedge into the kind of proper understanding that will enable them to successfully avoid danger.

It may be concluded that, apart from keeping children as far as possible apart from traffic at this age, a thorough training in real, but risk-free, traffic situations is required in order to ensure safe behaviour in risky situations that the children will occasionally have to deal with on their own. It is naive to think that young children can be wholly isolated from potentially dangerous traffic, and foolhardy not to teach them the skills necessary to deal with it.

5 References

Ampofo-Boateng, K. & Thomson, J.A. (1991). Children's perception of safety and danger on the road. *British Journal of Psychology, 82, 487-505.*

Briem, V. (1988). Barn i trafiken: Aktivitetsmönster och säkerhet på vägen till skolan. (Children in traffic: Activity patterns and safety on the way to school.) *Bulletin* **78**, Department of Traffic Technology, LTH, Lund University.

Case, R., Marini, Z., McKeough, A., Dennis, S., & Goldberg, J. (1986) Horizontal structures in middle childhood: Cross domain parallels in the course of cognitive growth. In I, Lewin (Ed.) *Stage and structure: Reopening the debate.* Norwood, NJ: Ablex.

Gagnon, J., Roth, J., Finzer, B., & Hoffman, R. (1991). *SuperANOVA.* Version 1.11. Berkely, CA: Abacus Concepts, Inc.

Haycock, K., Roth, J., & Gagnon, J. (1993). *StatView.* Version 4.01. Berkely, CA: Abacus Concepts, Inc.

Kail, R. (1990). More Evidence for a Common, Central Constraint on Speed of Processing. I: James T. Enns (Ed.) *The Development of Attention. Research and Theory.* Amsterdam : North-Holland.

Molen, H. H. van der (1981). Child pedestrian's exposure, accidents and behaviour. *Accident Analysis and Prevention, 13,* 193-224.

Pfeffer, K. & Barnecutt, P. (1996). Children's auditory perception of movement of traffic sounds. *Child Care, Health and Development,* **22**(2), 129-137.

Phinney, J., Colker, L., & Cosgrove, M. (1985). Literature Review on the Preschool Pedestrian. *US Department of Transportation, Literature Reviews, DOT HS 806 679.* Springfield, Virginia 22161: National Technical Information Service.

Rothengatter, J.A. (1981). *Traffic safety education for young children: an empirical approach.* Lisse, The Netherlands: Swets & Zeitlinger B.V.

Ryle, G. (1949). *The concept of Mind.* London: Hutchinson.

Salvatore, S. (1973). The ability of elementary and secondary school children to sense oncoming car velocity. *Highway Research Record,* **436**, 19-28.

Sandels, S. (1970). Young children in traffic. *British Journal of Educational Psychology,* **40**, 111-116.

Sandels, S. (1977). *Skandiarapporten I: Barnet i trafikmiljön. (The Skandia Report I: The Child in the Traffic Environment.)* Stockholm: Skandia.

Siegler, R. S. (1978). The origins of scientific reasoning. In R. S. Siegler (Ed.) *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.

Siegler, R. S. (1981). Developmental sequences within and between concepts. *Monographs of the Society for Research in Child Development, 46* (2, Serial No. 189).

SPSS (1990). *SPSS for the Macintosh 4.0.* Chicago, Ill.: SPSS, Inc.

Vinjé, M.P. (1981). Children as pedestrians: Abilities and limitations. *Accident Analysis and Prevention, 13,* 225-240.

Zelago, P. D., & Shultz, R. R. (1989). Concepts of potency and resistance in causal prediction. *Child Development, 60,* 1307-1315.