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Article

How Long Does It Take to Stop? Are Children Able to Stop on Demand?

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Featured Application: Authors are encouraged to provide a concise description of the specific application or a potential application of the work. This section is not mandatory.

Abstract: Distraction is a major contributor to road accidents, especially among children who are easily distracted and may not be fully aware of the traffic situation. It is crucial to understand that children up to a certain age may struggle to halt their movement once initiated. This study conclusively demonstrates that the stopping distance, time, and deceleration of children aged six to ten years after a specific stop signal at different speeds are strongly influenced by the speed of movement and the age of the children. The results show that in the “walking” test configuration, the children were able to stop within a range of 0.47 m to 0.63 m, with a shorter distance for older children. The stopping time ranges from 0.84 s to 1.21 s and correlates positively with age. The stopping time and distance of children were measured in both “running” and “walking” test configurations across different age groups. However, in the “running” test configuration, stopping distance is almost the same across all age groups, with children requiring between 1.72 m and 1.84 m and a stopping time ranging from 1.17 s to 1.28 s. In the “walking” test configuration, children are able to decelerate between 0.91 m/s² and 1.57 m/s², while in the “running” test configuration, they are able to decelerate between 2.24 m/s² and 3.19 m/s².

Keywords: children; stopping time; stopping distance

1. Scope

As children reach school age, they become more independent and active road users. Despite this, they remain the most vulnerable group of road users as pedestrians [1]. It is common for children to travel on foot to various destinations, including school, friends' houses, and sports activities [2]. The American Academy of Pediatrics recommends that children under the age of ten should not be unsupervised pedestrians in road traffic, except under special conditions [3]. However, it may not always be feasible to practice and supervise all trips. It is strongly advised that children practice walking to school with adult supervision before being allowed to walk alone [4]. According to research [5], children up to the age of approximately eight years are unpredictable and untrustworthy as pedestrians in road traffic due to their psychological development. Even older children, aged 8–9 years, are still easily distracted. Therefore, it is crucial for children to focus their attention on the hazardous situation and avoid distractions from other things [4,6–8]. Children crossing the road tend to focus on their immediate surroundings, often neglecting traffic [6,9]. It is vital to educate children on the significance of paying attention to traffic when crossing the road. Their attention is often drawn

to non-traffic related objects such as animals or other children [4,8]. Thus, inadequate observation of traffic and failure to stop before crossing the road are major contributing factors to accidents, as highlighted by sources [6,10,11]. Accurately estimating the speed and distance of an approaching vehicle is crucial to avoid critical situations. It is important to note that speed estimation is a complex task that requires considering distance [12]. According to various studies, children's ability to estimate distances ranges from approximately six [13] to approximately nine years [14], as cited in [12]. Additionally, children aged around 10 to 12 have been found to be capable of estimating the speed of approaching vehicles [14], as cited in [12]. It is worth noting that 10-year-old children tend to use distance rather than speed as a reference for their judgment [15]. Furthermore, Tapiro et al. [8] identified a correlation between time taken to clear the roadway and the speed of the next approaching vehicle. The study clearly demonstrates that younger children have a shorter escape time compared with the older children. Each age group (7-8 years, 9-10 years, 11-13 years, and adults) exhibited a significant difference to the next age group. Notably, the age group of 11-13-year-olds showed no significant difference compared with adults. The remaining escape time averaged at 0.7 seconds for 7-8 year olds, 2.7 seconds for the 9-10 year olds, and 4.9 seconds for the 11-13 year olds. Younger children were able to cross the road safely in significantly less time than adults, who had an escape time of 5.7 seconds. These findings suggest that younger children perceive a shorter distance between two vehicles as safe compared with adults or older children. However, in some situations, it may still be more appropriate for all pedestrians to stop and wait for traffic to pass or for vehicles to stop. Children aged six to seven struggle to interrupt a movement once it has begun, making it difficult to stop immediately in dangerous situations [16] (cited in [17]). This task requires a high level of alertness, which refers to the ability to quickly establish a general readiness to react [18]. It is important to note that alertness increases significantly between the ages of 5 and 11 years [19] (cited in [12]). However, for younger children (6-8 years), there are significant inter-individual differences. An average adult level of alertness is typically reached at around 14 years of age.

2. Objective

The objective of the study is to confidently analyze the stopping distance, stopping time, and deceleration of children of varying ages and movement speeds in response to a specific request.

3. Literature

Numerous studies have investigated the effect of different motion speeds of participants. These studies separated adults (e.g., Griffiths et al. [20], Knoblauch et al. [21] cited in [22], Forde and Daniel [23], Hussein and Sayed [24]) and children (e.g., Vaughan and Bain [25,26], Eberhardt and Himbert [27] cited in [26], Eubanks and Hill [28] cited in [26]) or analyzed both, adults and children (e.g., Strouhal et al. [29] cited in [30], Tarawneh [31], Kramer and Raddatz [32] cited in [30], Rahman et al. [33]). The studies categorized assessments into slow walking, normal walking, running and jogging, separated by gender. The tests were conducted in both road traffic conditions and a laboratory environment, with a constant focus on the steady-state speed of the participants. However, stopping time or stopping distance has been examined in only a few studies. For example, Wood et al. [34] examined the stopping distance of seven males and one female. The study conducted two test runs with participants jogging and walking at their preferred speed. An acoustic signal was used to prompt them to stop as quickly as possible, with the timing of the signal varied to prevent preparation. Tavana et al. [35] precisely measured the reaction time and stopping distance of 16 participants (nine males and seven females) at three different speeds, with each speed being tested three times. During the test configuration, participants followed a leading person at a comfortable distance. Participants were instructed to react promptly to the leader's sudden command to stop, without overtaking. The time and location of the stop were randomly selected and unknown to the participants. Zhang et al. [36] investigated the stopping distance of pedestrians (29 males and 25 females) in the context of pedestrian crowd stampede accidents. The tests were conducted at various

times and speeds. Pedestrian safety was thoroughly analyzed, including their ability to estimate the speed and stopping distance of oncoming vehicles [37,38], as well as predict the pedestrian's crossing path [39]. In their study, Kath et al. [40] found that vehicle drivers are willing to stop for pedestrians crossing the road. Meanwhile, Rajendar et al. [41] specifically examined the detection of pedestrians and the stopping distance of a vehicle equipped with an emergency braking system.

4. Method

The experiments were conducted in a child-friendly environment to prevent hazardous situations in real traffic conditions. This space is specifically designed to facilitate experimentation and learning in an enjoyable and safe manner.

4.1. Test Set-Up

The initial point was set 30 centimeters in front of the first light beam of the time-measuring device, which is 30 centimeters before the time measurement begins (**Error! Reference source not found.**). To prevent false activation of the time measurement, the starting point was adjusted based on preliminary tests that revealed children tend to move their arms at the starting point. The first light beam was triggered 30 centimeters after the starting point, and the timing began at this point. The second light beam was located one meter after the first, and the third light beam was positioned five meters after the first. Consequently, the distance between the second and third light beam was four meters. Time at all three light beams was used to calculate speed and acceleration.

The children's movement behavior was recorded in its entirety from a uniform perspective during all tests, which were each filmed from two fixed camera positions.

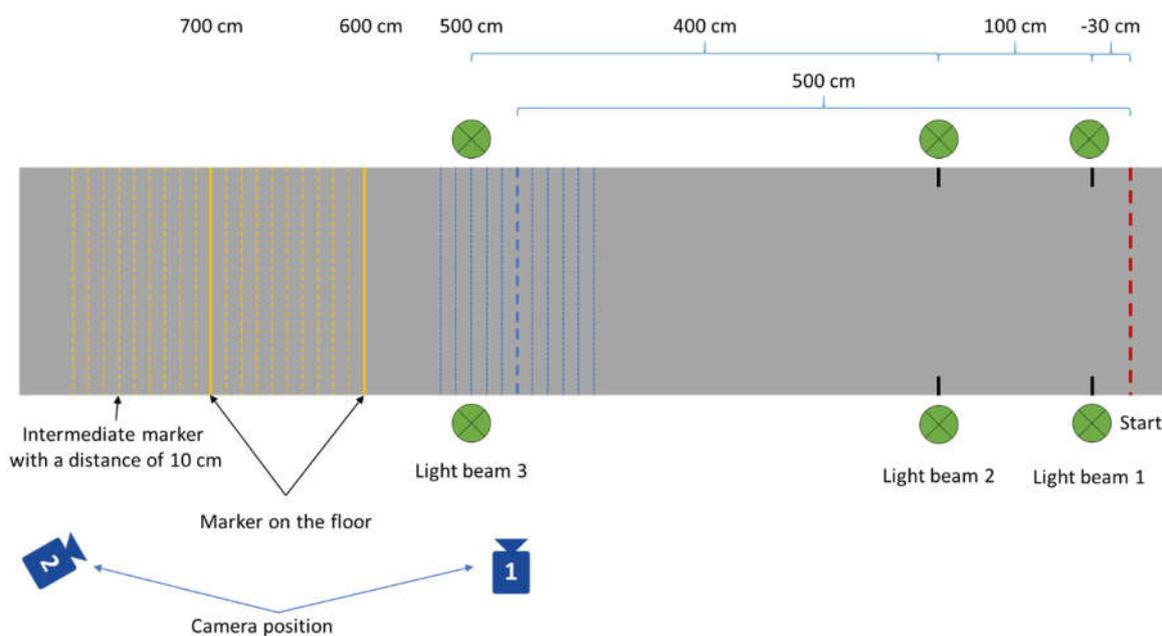


Figure 1. Sketch of the test set-up.

4.2. Test Matrix

The test configurations used in this study were consistent with those previously examined in the literature – including walking, running, and sprinting. Similar configurations have been investigated by Eberhard and Himbert [27] (cited in Bartels and Erbsmehl [30]), Eubanks and Hill [28] (cited in Vaughan and Bain [25,26]), and Vaughan and Bain [25,26,42]). Prior to testing, each child received clear instructions on which test to complete. The children were instructed to walk or run as they would normally do on a road. Each child completed five tests: two for walking, two for running, and one for running as fast as possible (sprinting). An acoustic stop signal was given after the third light

beam during the walking and running tests. The signal time was varied to prevent anticipation and ensure the children's ability to stop remained unaffected. The children were given clear instructions to freeze immediately upon receiving the signal. During the sprinting test, they were instructed to run as fast as possible to the end of the track and stop. It was not necessary to give a stop signal during this test configuration.

4.3. Sample

The study included a sample of 93 primary school children, consisting of 39 female and 54 males, ranging in age from six to ten years. A total of 32 children were six years old (34.4%), 17 children were seven years old (18.3%), 23 children were eight years old (24.7%), 19 children were nine years old, and two children were 10 years old and grouped together (22.6%). Physiological parameters, such as height and weight, were recorded by age group and are presented in **Error! Reference source not found.**

Table 1. Sample size of the different age groups differentiated by gender.

Physiological parameter	6 years	7 years	8 years	9–10 years
Number of children	32	17	23	21
Females	11	8	11	9
Males	21	9	12	12

4.4. Data Analysis

Error! Reference source not found. illustrates the theoretical speed-distance characteristic. The children begin at the starting point (SP) and accelerate to the target speed. It is assumed that they maintain a constant steady-state speed until they reach the third light beam (LB3). Following the third light beam, an acoustic signal is given, and the deceleration phase commences.

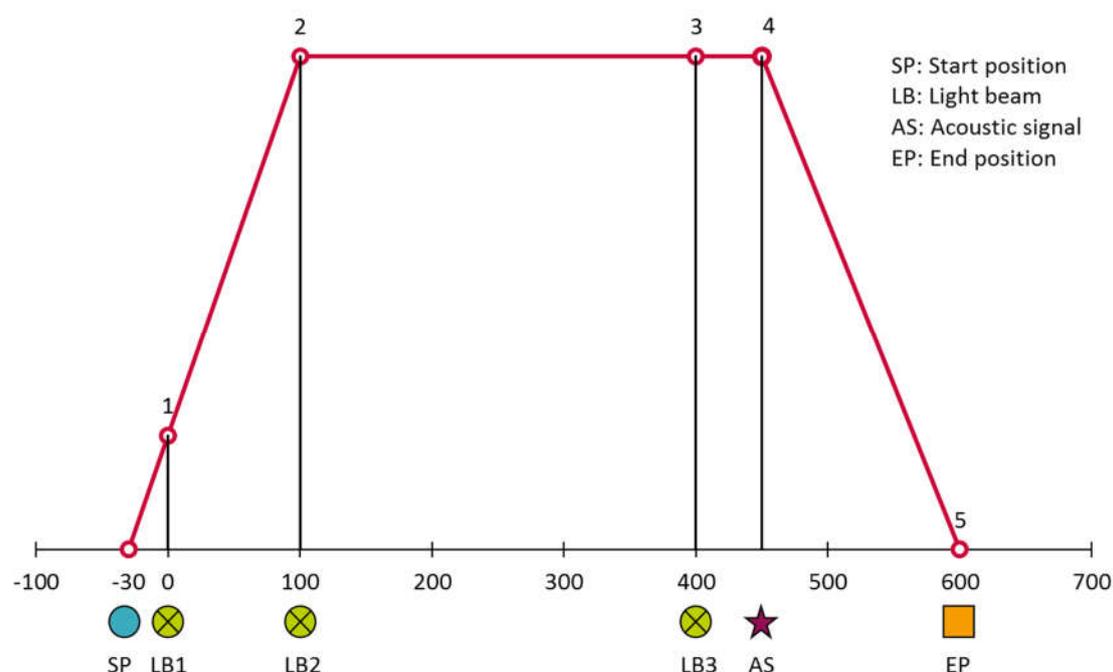


Figure 2. Theoretical velocity-distance characteristic.

Formula 1 was used to calculate the speed at steady state, taking into account the distance between the second (LB2) and third light beam (LB3) (s_3-s_2) and the time difference captured at the light beams LB2 and LB3 (t_3-t_2). The distance that the children moved from the acoustic signal to the

final position was also measured. Based on the speed and the distance moved, the deceleration from the acoustic signal to the rest position was calculated (Formula 2). Deceleration time was not measured separately from the time it took to react to the signal.

$$v = \frac{s_3 - s_2}{t_3 - t_2} \quad (1)$$

$$a = \frac{v^2}{2(s_{EP} - s_{AS})} \quad (2)$$

5. Results

The walking speeds of the different age groups were significantly different from each other, as determined by a single-factorial ANOVA ($p=0.005$), see **Error! Reference source not found.** (A summary of the results for boys and girls can be found in the Appendix). The walking speed of seven-year-olds was significantly different from that of nine-year-olds ($p=0.002$) (Tukey post-hoc test), while no significant difference were observed among the other age groups. A notable difference was found only between the seven-year-olds and the eight-year-olds ($p=0.065$).

The results also show a significant difference between the age groups for the “running” test configuration (single-factorial ANOVA, $p=0.003$). Specifically, the speed difference between six-year-olds and nine-year-olds was significant in the “running” test ($p=0.001$), as well as between eight-year-olds and nine-year-olds ($p=0.041$) (Tukey post-hoc test).

For the “sprinting” test configuration, a single-factorial ANOVA yielded a significant difference between age groups ($p=0.000$). The Tukey post-hoc test revealed significant differences between the age groups of six-year-olds and seven-year-olds ($p=0.021$), six-year-olds and eight-year-olds ($p=0.000$), and six-year-olds and nine-year-olds ($p=0.000$).

Notably, there was no statistically significant difference found between boys and girls in terms of speed in the “walking” and “running” test configurations within each age group. A significant gender difference ($p=0.007$) was found between eight-year-old boys and girls in the “sprinting” test configuration.

Table 2. Steady-state speed in km/h of the different test configurations according to age groups between the second and third light beam (standard deviation: SD; first quartile: Q1; third quartile: Q3).

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	32	3.69	0.94	2.11	3.04	3.44	4.43	5.69
	7 years	17	3.16	0.86	1.82	2.60	3.01	3.60	5.60
	8 years	23	3.78	0.58	2.55	3.44	3.73	4.15	5.35
	9–10 years	21	4.09	0.91	2.14	3.45	4.03	4.52	6.21
Running	6 years	32	9.59	1.65	5.12	8.23	9.47	10.76	12.85
	7 years	17	10.39	2.17	6.46	8.47	11.21	11.98	13.84
	8 years	23	10.03	1.68	6.82	8.74	9.80	11.50	13.84
	9–10 years	21	11.41	1.75	8.14	10.06	11.57	12.52	15.65
Sprinting	6 years	32	11.86	1.44	7.62	11.29	11.90	12.74	13.98
	7 years	17	12.87	1.11	10.06	12.30	12.97	13.33	14.54
	8 years	23	13.25	1.02	11.42	12.52	13.33	13.91	15.65
	9–10 years	21	13.64	0.66	12.52	13.09	13.58	13.98	14.84

In the “walking” test configuration, an average stopping distance of 0.63 m was recorded for six-year-olds (**Error! Reference source not found.**). Stopping distance tends to decrease with increasing age and was found to be 0.47 m on average for 9–10 year olds. The Welch-ANOVA test revealed a statistically significant difference between age groups ($p=0.030$). Further analysis using the Games-Howell post hoc test showed that only the six-year-olds and the 9–10-year-olds exhibited a significant

difference ($p=0.017$). The “running” test configuration produced a stopping distance ranging from 1.72 m to 1.85 m. No significant difference was found between age groups for the “running” test configuration.

Table 3. Average stopping distance to standstill after the acoustic signal.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	32	0.63	0.23	0.35	0.45	0.55	0.78	1.23
	7 years	17	0.53	0.28	0.23	0.35	0.40	0.63	1.20
	8 years	23	0.54	0.12	0.28	0.50	0.55	0.63	0.75
	9–10 years	21	0.47	0.14	0.20	0.38	0.45	0.55	0.78
Running	6 years	32	1.74	0.43	0.80	1.41	1.79	2.10	2.40
	7 years	17	1.84	0.79	0.90	1.33	1.60	2.18	4.10
	8 years	23	1.72	0.63	0.85	1.26	1.70	2.03	3.93
	9–10 years	21	1.85	0.61	0.25	1.50	1.93	2.23	2.85
Sprinting	6 years	32	0.63	0.23	0.35	0.45	0.55	0.78	1.23
	7 years	17	0.53	0.28	0.23	0.35	0.40	0.63	1.20
	8 years	23	0.54	0.12	0.28	0.50	0.55	0.63	0.75
	9–10 years	21	0.47	0.14	0.20	0.38	0.45	0.55	0.78

Error! Reference source not found. clearly demonstrates a trend in stopping time for both walking and running, with older children exhibiting significantly faster stopping times than younger children. The difference in stopping time between age groups for walking is statistically significant (Welch-ANOVA test, $p=0.000$). Additionally, the Games-Howell test reveals statistically significant differences in stopping time between six- and seven-year-olds ($p=0.042$), six- and nine-year-olds ($p=0.000$), seven- and nine-year-olds ($p=0.017$), and eight- and nine-year-olds ($p=0.019$). There is no significant difference between age groups, despite the fact that older children tend to stop more quickly in the “running” configuration.

Table 4. Average stopping time to standstill after the acoustic signal.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	11	1.21	0.26	0.67	1.02	1.20	1.34	1.92
	7 years	8	1.16	0.37	0.75	0.88	1.06	1.51	1.85
	8 years	11	1.03	0.20	0.63	0.89	1.04	1.17	1.47
	9–10 years	9	0.84	0.22	0.35	0.68	0.87	0.92	1.34
Running	6 years	11	1.28	0.26	0.67	1.12	1.27	1.45	1.83
	7 years	8	1.25	0.37	0.72	0.98	1.26	1.38	2.31
	8 years	11	1.22	0.29	0.65	1.10	1.26	1.31	2.17
	9–10 years	9	1.17	0.30	0.36	1.10	1.24	1.39	1.50

The analysis of deceleration shows a similar trend, albeit with an opposite tendency. As children grow older, they achieve higher deceleration values in both in the “walking” and “running” test configurations (**Error! Reference source not found.**). However, these results are not statistically significant in either configuration ($p=0.167$ and $p=0.284$, single-factorial ANOVA).

Table 5. Average stopping deceleration to standstill after the acoustic signal.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	32	0.91	0.31	0.50	0.70	0.83	1.08	1.95
	7 years	17	0.81	0.23	0.44	0.67	0.77	0.94	1.27

	8 years	23	1.07	0.26	0.73	0.86	1.09	1.26	1.62
	9–10 years	21	1.57	0.68	0.73	1.15	1.45	1.90	3.35
Running	6 years	32	2.24	0.61	1.41	1.96	2.12	2.35	3.93
	7 years	17	2.51	0.90	1.53	2.13	2.35	2.75	4.99
	8 years	23	2.44	0.72	1.77	2.01	2.20	2.58	4.65
	9–10 years	21	3.19	1.68	1.83	2.27	2.72	3.29	8.06

Speed significantly affects the length of stopping distance and stopping time. The relationship between stopping distance, stopping time, and steady-state speed for the “walking” and “running” test configurations is shown in **Error! Reference source not found.** and **Error! Reference source not found.**. The data clearly indicates an increase in stopping distances at higher speeds ($R=0.58$ for “walking” and $R=0.63$ for “running”). Notably, this trend is not observed for stopping time.

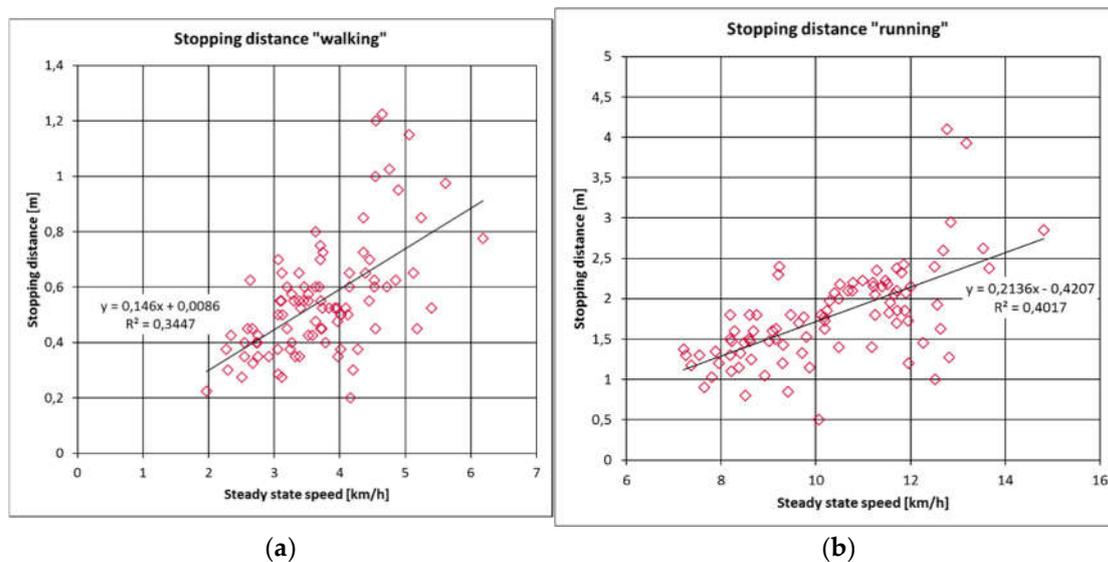


Figure 3. Correlation between steady-state speed and stopping distance: (a) walking test configuration; (b) running test configuration.

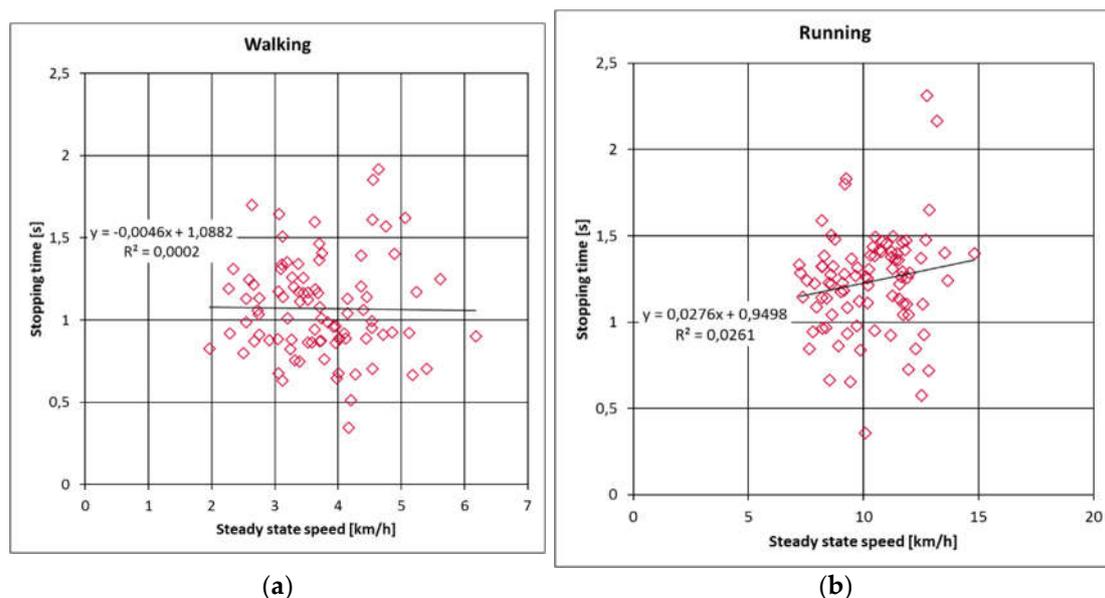


Figure 4. Correlation between steady-state speed and stopping time: (a) walking test configuration; (b) running test configuration.

6. Discussion

During the tests, we carefully considered the boundary conditions of the test setup and determined that the length of the test course differs from what is stated in the literature. While Vaughan and Bain's complete test course [25,26,42] was 15 meters long, we confidently assumed that the first five meters were assumed to be the acceleration phase. Eberhard and Himbert [27] (cited in Bartels and Erbsmehl [30]) used a test set-up with a complete course length of 10 meters. However, the length of the acceleration phase was not specified. Strouhal et al. [29] (also cited in Bartels and Erbsmehl [30]) used a course length of 10 meters to determine only steady-state speed, indicating that the participants did not accelerate from standstill. The recorded steady-state speeds of the children in different age groups are comparable with findings in the literature. However, they are lower than those reported by some previous studies (see Vaughan and Bain [25,26,42], Eberhard and Himbert [27] (cited in Bartels and Erbsmehl [30]), Eubanks and Hill [28] (cited in Vaughan and Bain [25,26])). These differences may be related to the test configuration. The children will reach a constant speed after the second light beam, following an acceleration phase of 1.3 meters. It is important to note that if the children do not reach a constant speed immediately after this brief acceleration phase, they will continue to accelerate, despite the assumption of a steady-state speed. Between the second and third light beams, a steady-state speed is assumed, but there is still acceleration. It is important to note that the steady-state speed reached after the second light beam may be underestimated and possibly lower compared with the literature. As shown in **Error! Reference source not found.**, if the distance and time between the second and third light beams are used to calculate steady-state speed, it would be 7.2 km/h. During the acceleration phase, a lower speed can be calculated based on the distance and time between light beams. In this particular example, the steady-state speed between the first and second light beams is calculated to be 6 km/h.

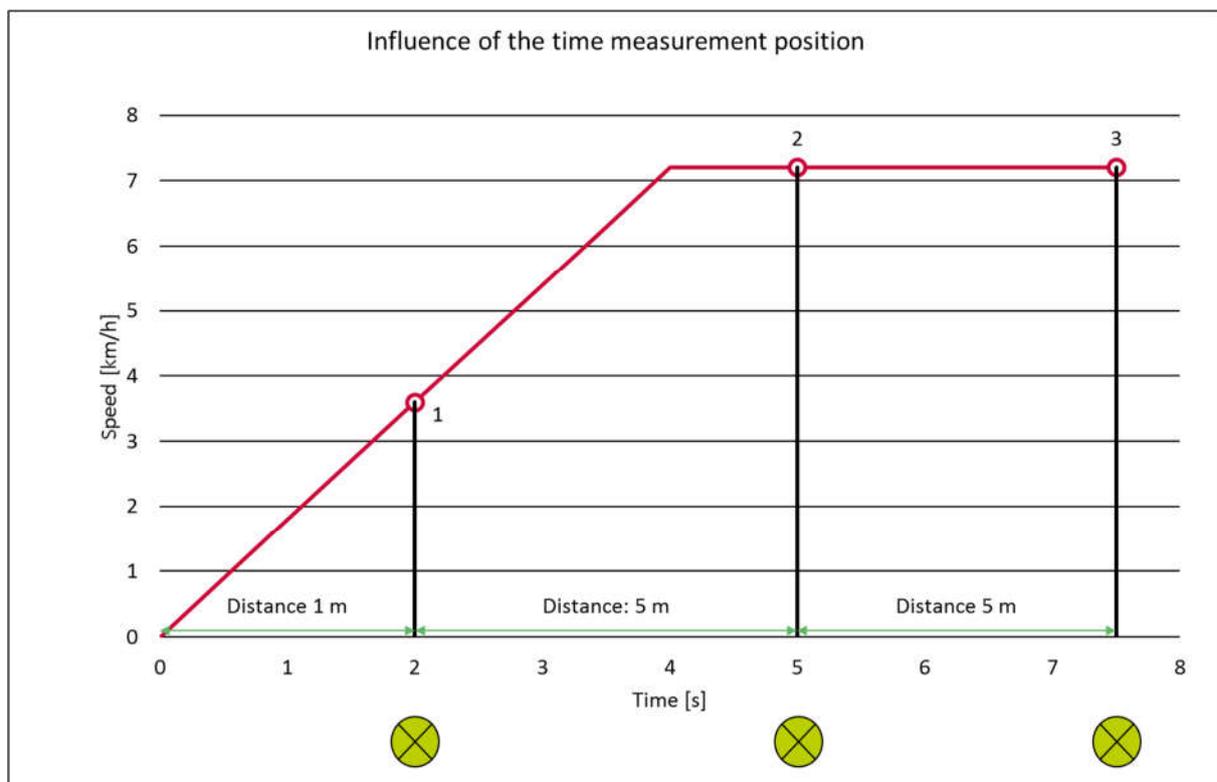


Figure 5. Influence of the length of the test set-up.

Older children, both girls and boys, tend to exhibit higher speeds, which is consistent with the literature. Although steady-state speed is lower compared with the literature, this finding does not contradict the observed tendency. Several studies have provided a categorization by specific age groups and gender, including Vaughan and Bain [25,26,42], Eberhard and Himbert [27] (cited in

Vaughan and Bain [25,26]), and Eubanks and Hill [28] (cited in Vaughan and Bain [25,26]). The results show that older children achieve higher speeds. Boys tend to have higher speed than girls, according to Vaughan and Bain [25,26,42], as well as Eberhard and Himbert [27] (cited in Vaughan and Bain [25,26]). However, this observation was not found in the current study.

Publicly accessible studies on the stopping distance or deceleration of children differentiated by age groups are currently lacking. However, the existing literature on deceleration behavior primarily focuses on adults and their body postures immediately before collision [43–46]. It is important to note that these postures can significantly influence injury patterns and injury severity. Research predicts movement trajectories of pedestrians [47,48] and investigates movement characteristics of healthy individuals and those with a unilateral transtibial leg prosthesis [49]. The study confidently determined a steady-state speed with a time to stop of approximately 1.6 seconds (Goldhammer et al. [50]), while senior citizens and children had average times to stop of 3.25 seconds (SD=1.25) and 3.14 seconds (SD=1.13), respectively. These observations suggest that age group may not be a significant factor in reaction time, although further research is needed to confirm this conclusion. According to Tavana et al. [35], the average time to stop was 0.58 seconds (SD=0.31) with a total stopping distance of 0.63 meters and a total stopping time of 1.08 seconds. Notably, the maximum speed in Tavana et al. [35] is comparable with the steady-state speed in the “walking” test configuration and the average stopping time of this test configuration. Additionally, the stopping distance in the “walking” configuration ranges from 0.47 to 0.63 meters at a steady-state speed of between 3.1 and 4.4 km/h. The study’s “walking” test configuration clearly demonstrates that older children have a significantly shorter average stopping distance than younger ones, with the stopping time required to decelerate from steady-state speed to standstill ranging from 0.84 s to 1.21 s and showing a negative correlation with children’s age. Furthermore, in the “running” test configuration, the stopping distances of the different age groups are found to be similar, further supporting the study’s conclusions. Stopping distance ranges from 1.72 m to 1.84 m, and stopping time ranges from 1.17 s to 1.28 s. The time required to decelerate from steady-state speed to standstill decreases with age. These results demonstrate a clear relationship between age and stopping performance. Perception reaction time after the acoustic signal is not explicitly evaluated, but it can be inferred from stopping distance and the deceleration phase. The specific braking distance is shorter, and the deceleration values achieved are potentially higher. Children can achieve a deceleration ranging from 0.91 m/s² (six years old) to 1.57 m/s² (9 to 10 years old) in the “walking” test configuration. In the “running” test configuration, deceleration ranges from 2.24 m/s² (six years old) to 3.19 m/s² (9 to 10 years old). According to Zou et al. [51], pedestrians exhibit a median deceleration of 4.2 m/s² in response to hazardous situations, demonstrating a clear effort to avoid collisions.

7. Limitations

Although the children were instructed on how to carry out the tests, they did not always follow the theoretical velocity-distance characteristics. The acceleration phase was not completed before the second beam and therefore the steady-state velocity between the second and third beams was underestimated. Sometimes they started to reduce their speed too early, i.e., before they had passed the third light beam or before the acoustic signal was given. The stopping distance is therefore underestimated.

The position of the children at the time of the acoustic signal is extracted from the video source. The position was not measured precisely with a measuring device. The position was estimated from the video data analysis and is therefore not accurately recorded.

The tests were carried out in a non-hazardous environment. The extent to which the results can be extrapolated to real traffic conditions is not entirely clear and should be treated with care.

8. Conclusion

The study's findings emphasize the crucial importance of unobstructed visibility of the roadside in road space design. Obstructed visibility can prevent children from stopping immediately upon recognizing danger while crossing the lane. It is worth noting that the stopping distance when running is almost two meters, which means that children may come to a stop in the middle of the lane.

Stopping distance is a function of speed, and it increases as speed increases. Therefore, it can be concluded that stopping distance is not solely dependent on age, but rather on a combination of factors. Age is one factor in stopping distance, but in the "running" test configuration, older children have a similar stopping distance to younger children despite their higher speed and quicker reaction time. Older children reach higher speeds and therefore experience greater deceleration than younger children.

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Appendix A: Girls

Table A1. Average steady-state speed of the different test configurations according to age groups of girls.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	11	3.98	1.03	2.12	3.14	3.96	4.78	5.69
	7 years	8	3.23	0.89	1.92	2.72	3.11	3.63	5.22
	8 years	11	3.70	0.38	2.93	3.47	3.64	3.88	4.62
	9–10 years	9	3.74	0.82	2.54	3.29	3.58	3.87	5.85
Running	6 years	11	9.78	1.17	7.54	9.10	10.00	10.70	11.61
	7 years	8	10.99	1.95	7.46	9.97	11.71	12.26	13.33
	8 years	11	10.05	1.74	7.38	8.67	9.70	11.75	13.21
	9–10 years	9	10.85	1.58	8.14	9.72	11.25	12.18	12.74

Table A2. Average stopping distance to standstill after the acoustic signal of the different test configurations according to age groups of girls.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	11	0.72	0.24	0.38	0.51	0.80	0.91	1.03
	7 years	8	0.54	0.30	0.23	0.35	0.48	0.64	1.15
	8 years	11	0.56	0.11	0.40	0.50	0.55	0.63	0.75
	9–10 years	9	0.47	0.10	0.29	0.43	0.45	0.53	0.63
Running	6 years	11	1.86	0.39	1.25	1.56	2.08	2.14	2.30

7 years	8	1.93	0.63	0.90	1.56	1.96	2.26	2.95
8 years	11	1.73	0.36	1.20	1.46	1.73	1.95	2.40
9–10 years	9	1.69	0.39	1.00	1.50	1.63	1.95	2.35

Table A3. Average stopping time to standstill after the acoustic signal of the different test configurations according to age groups of girls.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	11	1.29	0.24	0.89	1.19	1.26	1.48	1.61
	7 years	8	1.17	0.42	0.75	0.81	1.05	1.63	1.70
	8 years	11	1.08	0.24	0.76	0.89	1.12	1.25	1.47
	9–10 years	9	0.93	0.21	0.66	0.86	0.87	1.01	1.34
Running	6 years	11	1.36	0.20	1.04	1.24	1.41	1.45	1.80
	7 years	8	1.25	0.29	0.84	1.04	1.32	1.42	1.65
	8 years	11	1.24	0.11	1.04	1.18	1.26	1.31	1.37
	9–10 years	9	1.15	0.29	0.58	0.93	1.22	1.32	1.50

Table A4. Average stopping deceleration of the different test configurations according to age groups of girls.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	11	0.89	0.24	0.50	0.75	0.86	1.02	1.26
	7 years	8	0.85	0.30	0.44	0.64	0.86	1.00	1.27
	8 years	11	1.02	0.26	0.73	0.81	0.90	1.26	1.40
	9–10 years	9	1.32	0.63	0.73	0.88	1.19	1.46	2.85
Running	6 years	11	2.04	0.25	1.42	1.99	2.10	2.20	2.30
	7 years	8	2.61	0.75	1.70	2.22	2.39	2.87	4.18
	8 years	11	2.30	0.40	1.85	1.99	2.19	2.57	3.16
	9–10 years	9	3.21	1.96	1.83	2.08	2.72	3.65	8.06

Appendix B: Boys

Table A5. Average steady-state speed of the different test configurations according to age groups of boys.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	21	3.54	0.86	2.11	2.92	3.32	4.20	5.41
	7 years	9	3.09	0.86	1.82	2.57	2.81	3.52	5.60
	8 years	12	3.86	0.72	2.55	3.30	3.80	4.25	5.35
	9–10 years	12	4.35	0.89	2.14	3.95	4.32	4.69	6.21
Running	6 years	21	9.49	1.85	5.12	8.13	9.26	11.12	12.85
	7 years	9	9.85	2.26	6.46	8.09	9.01	11.75	13.84
	8 years	12	10.01	1.65	6.82	9.14	9.80	10.92	13.84
	9–10 years	12	11.83	1.79	8.94	10.63	11.80	13.33	15.65

Table A6. Average stopping distance to standstill after the acoustic signal of the different test configurations according to age groups of boys.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	21	0.57	0.22	0.35	0.45	0.50	0.63	1.23
	7 years	9	0.52	0.29	0.28	0.35	0.40	0.60	1.20
	8 years	12	0.53	0.13	0.28	0.49	0.55	0.61	0.73
	9–10 years	12	0.47	0.16	0.20	0.34	0.49	0.56	0.78

Running	6 years	21	1.67	0.44	0.80	1.41	1.73	1.83	2.40
	7 years	9	1.75	0.93	1.10	1.30	1.38	1.63	4.10
	8 years	12	1.71	0.82	0.85	1.19	1.58	2.01	3.93
	9–10 years	12	1.97	0.72	0.25	1.74	2.15	2.43	2.85

Table A7. Average stopping time to standstill after the acoustic signal of the different test configurations according to age groups of boys.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	21	1.16	0.27	0.67	0.99	1.14	1.28	1.92
	7 years	9	1.16	0.34	0.80	0.92	1.06	1.26	1.85
	8 years	12	0.99	0.16	0.63	0.91	1.00	1.09	1.20
	9–10 years	12	0.77	0.21	0.35	0.67	0.79	0.91	1.08
Running	6 years	21	1.24	0.28	0.67	1.06	1.24	1.44	1.83
	7 years	9	1.25	0.45	0.72	0.98	1.18	1.33	2.31
	8 years	12	1.20	0.40	0.65	0.94	1.21	1.33	2.17
	9–10 years	12	1.17	0.36	0.18	1.13	1.26	1.40	1.47

Table A8. Average stopping deceleration of the different test configurations according to age groups of boys.

Test	Age group	Number	Mean	SD	Min	Q1	Median	Q3	Max
Walking	6 years	21	0.92	0.35	0.53	0.70	0.76	1.09	1.95
	7 years	9	0.78	0.16	0.59	0.67	0.72	0.94	1.05
	8 years	12	1.13	0.25	0.75	0.98	1.13	1.24	1.62
	9–10 years	12	1.76	0.69	0.85	1.26	1.76	2.03	3.35
Running	6 years	21	2.35	0.73	1.41	1.82	2.28	2.75	3.93
	7 years	9	2.43	1.06	1.53	1.59	2.35	2.56	4.99
	8 years	12	2.57	0.92	1.77	2.04	2.25	2.65	4.65
	9–10 years	12	3.17	1.52	2.15	2.37	2.77	3.20	7.81

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