Testing a Training Program That uses Virtual Reality Technology to Improve Children's Pedestrian Behaviors: A Randomized Controlled Trial

#NCT-03960047

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SETTING

We focus on midblock crossing on two-lane bidirectional roads, without nearby traffic signals or crosswalks.

For SS-T sessions, a road has been identified (50 km limit) that provides opportunity for training in *where* and *how* to cross in the same types of road situations to be presented in VR-T. Traffic volume was recently measured for 7 days and varied from light (8 cars/min) to heavy (16 cars/min).[13,30] This range for traffic volume will occur in VR-T.

For VR-T sessions, these occur in the VR lab at UG campus.

For pre and post measures, for all groups these occur in two settings: **(a)** street side (designated as "Field*"* below) with naturally varying traffic (children indicate where and how they will cross but do not do so), **(b)** in the VR lab in which children cross the virtual street in traffic using a gaming controller.

Note that the pre/post Field measures will be taken at two locations along the *same* road (randomized order, with one used for pre and the other for post), which controls for familiarity and minimizes risk of large variation in traffic volume between pre/post measures. The road is nearby the VR lab, which allows children to complete pre-test VR *and* Field measures during the *same* visit to UG; the same will occur for post-test measures. Posted speed is 50 km, which means traffic conditions to be tested on are ones that pose risk of severe injury at these ages.[13, 57]

TESTING PROTOCOL

Pre/Post measures for Where and How to Cross

[Note that pre- and post- measures are the same, and all children, regardless of group, complete all measures.]

Field Measures**.** For *where* to cross measures, the child selects the safest location to cross in 3 different street side situations (parked cars, hill, blind curve). For *how* to cross measures: the child stands 1 foot from the curb, with a pressure sensitive step plate in front of him (it connects to a laptop; a clear plastic wall prevents entry into the street), and completes a '2 step procedure' (based on observed traffic, take 2 steps forward, corresponding to initiating a street crossing;[23,58] from this we estimate crossing measures.[NOTE: Street side testing is video recorded so traffic and crossing measures can be computed later; the PI has used this procedure before.[59]]

VR Measures. The same measures as for Field, except completed within a virtual street environment.

Pre-Training Activities & Measures

VR-T. An initial Orientation and Movement-Control Training Module ensures all children are practiced with using the controller to navigate in the 3-D world to the same motor skill level, *before* starting pedestrian training. The controller allows them to vary their path, direction, and speed of walking and crossing.

SS-T**.** Children's average walking speed for crossing is determined[58] and then, in combination with video taken street side, is used to estimate crossing measures – so they do not cross in traffic, but only give initiation judgements. This is a common approach that the PI has used before.[59]

Training Programs [All program decisions were informed by pilot testing.]

Each includes 6 training sessions of 30 minutes (2% of our pilot sample needed a break) and addresses *where* and *how* to look and cross. Performance is tracked on a trial-by-trial basis, and errors result in repetition of teaching trials, resulting in more training on skills they lack than those they have. Difficulty level generally increases over sessions as children acquire skills.

VR-T**.** Children experience trials from each of three training modules that are organized logically for how one crosses: **(1)** deciding *where to cross* (component skills: identify a safe place with parked cars, traffic on hills, traffic on blind curves); **(2)** *effective looking* (component skills: left-right-left, always left as one enters the road); **(3)** *how to cross safely* (component skills: check traffic in both directions, select larger gaps, start right in when car back bumper passes). On each trial, the computer talks and provides immediate feedback on performance so children know if they safely completed the trial (e.g., "Great job") or what they did that was unsafe and why (replays of what the child did are shown and explained), and what to do instead. A component skill is tested (with explanatory feedback given for failures) until the child achieves at least 80% success over a minimum of 5 trials or completes 15 trials. They then move on to test another component skill, with failed component skills retested in a future session. Over sessions, they get repeated training on all modules and component skills, but repetition focuses mostly on skills they still need to achieve.

SS-T**.** This program is grounded in behavior theory (modeling, reinforcement) and modeled after Kerbcraft[60] a program shown to improve children's safe crossing behaviors. The program also includes *where* and *how* content and is organized similarly to VR-T (modules, teach component skills, immediate feedback). Over sessions, they get training on all modules and component skills, with repetition focusing on weaker skills.

STATISTICAL ANALYSIS PLAN

The CONSORT flowchart diagram will guide all reporting of results and an intention-to-treat analysis will be conducted, as appropriate.

Covariates

Summary statistics will be computed for baseline and demographic characteristics. When imbalances occur between groups, despite randomization, these variables will be included as covariates. Likely covariates include: (a) Child age; (b) Child Pedestrian Experience questionnaire data (parent report), which yields average weekly distance walked and other potential covariate indices;[68] (c) # of days between pre- and post- tests; (d) family income.

Primary Analyses

Behaviors. We will document the baseline characteristics of each of the 3 groups (age, sex, walking experience, days between pre- and post- tests, family income, and traffic volume for field measures). We will produce point estimates and confidence intervals for the mean difference between pre- and post-immediate scores (i.e., change scores) for each group and each *where* (1 score), *how* (3 scores), and *consequence* (2 scores) outcome. We will then use linear regression of change score on group adjusting for covariates. We will extend this approach to multivariate (modeling multiple outcomes) linear regression incorporating all of the outcomes into one model and employing an adjustment for multiple comparisons. We will include interaction terms between group and sex to determine if child sex modifies program effects. An intention-to-treat approach will be followed. The goal is to assess for immediate gains following program completion in our outcomes (for Sustainability see Secondary Analyses).

Secondary Analyses

Behaviors. These will examine pre- to post-immediate changes in *Component Skills* performance (e.g., *where*: selecting safe location with parked cars) and examine from post-immediate to post-2 months later (to assess for sustainability of effects), comparing pre to post scores using the same approach as above.