THE JOURNAL OF
CHILD PSYCHOLOGY AND PSYCHIATRY

Journal of Child Psychology and Psychiatry **:* (2009), pp **–** doi:10.1111/j.1469-7610.2009.02137.x

Virtual learning intervention to reduce bullying victimization in primary school: a controlled trial

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Background: Anti-bullying interventions to date have shown limited success in reducing victimization and have rarely been evaluated using a controlled trial design. This study examined the effects of the FearNot! anti-bullying virtual learning intervention on escaping victimization, and reducing overall victimization rates among primary school students using a nonrandomized controlled trial design. The program was designed to enhance the coping skills of children who are known to be, or are likely to be, victimized. **Methods:** One thousand, one hundred twenty-nine children (mean age 8.9 years) in 27 primary schools across the UK and Germany were assigned to the FearNot! intervention or the waiting control condition. The program consisted of three sessions, each lasting approximately 30 minutes over a three-week period. The participants were assessed on self-report measures of victimization before and one and four weeks after the intervention or the normal curriculum period. **Results:** In the combined sample, baseline victims in the intervention group were more likely to escape victimization at the first follow-up compared with baseline victims in the control group (adjusted RR, 1.41; 95% CI, 1.02–1.81). A dose–response relationship between the amount of active interaction with the virtual victims and escaping victimization was found (adjusted OR, 1.09; 95% CI, 1.003–1.18). Subsample analyses found a significant effect on escaping victimization only to hold for UK children (adjusted RR, 1.90; CI, 1.23–2.57). UK children in the intervention group experienced decreased victimization rates at the first follow-up compared with controls, even after adjusting for baseline victimization, gender and age (adjusted RR, .60; 95% CI, .36–.93). **Conclusions:** A virtual learning intervention designed to help children experience effective strategies for dealing with bullying had a short-term effect on escaping victimization for a priori identified victims, and a short-term overall prevention effect for UK children. **Keywords:** Anti-bullying intervention, victimization, virtual learning, controlled trial. **Abbreviation:** FearNot!: Fun with Empathic Agents to achieve Novel Outcomes in Teaching.

School bullying, defined as intentional and repeated aggression towards weaker peers, is a widespread phenomenon that is most prevalent among primary school children (Olweus, 1993). In particular, bullying victimization is associated with behavior and school adjustment problems, high levels of depression and anxiety, and poor physical health (Arseneault et al., 2006; Bond, Carlin, Thomas, Rubin, & Patton, 2001; Fekkes, Pijpers, Fredriks, Vogels, & Verloove-Vanhorick, 2006).

Current anti-bullying interventions have demonstrated some positive outcomes in regard to reducing victimization (Baldry & Farrington, 2007). However, most intervention effects are small or overestimates as studies do not adjust for the non-independence of observations that occurs when individuals are analyzed within clusters (i.e., classes) (Vreeman & Carroll, 2007). Reducing bullying behavior has proven even less successful (P.K. Smith, Ananiadou, & Cowie, 2003).

Another supplementary approach to reducing victimization by bullies is to support the victims by increasing their coping competence. There is strong evidence that victimized children lack the coping skills to manage confrontation with bullies adaptively and successfully (Champion, Vernberg, & Shipman, 2003). The proposed intervention model is grounded on active problem-solving approaches to stress. According to the cognitive theory of stress and coping, introduced by Lazarus and Folkman (1984), an individual's adaptation to stressful events such as victimization is dependent upon the ability to use active coping strategies to reduce the source of stress. The learning of such coping skills is most effectively achieved, according to social learning theories, when individuals can directly experience

Conflict of interest statement: No conflicts declared.

Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

and become emotionally involved in situations that are highly similar to the actual situation that requires coping (Bandura, 1986; Kolb, 1984). One recent approach pioneered for different clinical conditions is to enhance coping strategies by learning and testing coping approaches in a virtual environment (Krijn, Emmelkamp, Olafsson, & Biemond, 2004). A particular challenge is to create 'presence' in virtual social environments that make the user behave and feel as if they were in the virtual world created by computer displays. This is called immersion, which refers to the technical capability of the system to deliver a surrounding and convincing environment with which the participant can interact (Sanchez-Vives & Slater, 2005).

The purpose of the current study was to examine the effectiveness of a new immersive learning intervention, called FearNot! (Fun with Empathic Agents to achieve Novel Outcomes in Teaching), in helping identified victims escape victimization, and reduce overall bullying victimization among children. The program was designed to enhance the problem-solving skills of current or potential victims of bullying by encouraging students to generate and evaluate a wide range of responses to bullying in a safe environment that ensured privacy.

A pre-test/post-test control group design was employed. Firstly, we predicted that the FearNot! intervention would be effective in helping victims identified at baseline to escape further victimization (secondary preventive effect). Secondly, we hypothesized that FearNot! would significantly decrease self-reported victimization among intervention classes compared to non-intervention classes (primary preventive effect). For both types of effect, we investigated whether there is a dose–response relationship of interaction intensity with the FearNot! characters and victimization reduction. Finally, we tested whether the intervention is safe, and does not inadvertently increase bullying perpetration.

Methods

Setting and participants

The study was conducted during the school year of 2007–2008. Primary schools in the areas of Warwickshire, Coventry and Hertfordshire in the UK, and Bavaria and Hesse in Germany, were recruited by mailing letters describing the study to the school principals. The letters were followed up by telephone calls. Of the 39 schools approached, 27 agreed to participate in the trial (18 in the UK and 9 in Germany). Schools were eligible to take part if they were state schools and mixed sex, students were aged 7–11 years, and were not already implementing another specific anti-bullying intervention beyond a general anti-bullying school policy (Woods & Wolke, 2003). All Year 5 English pupils and Year 3 German pupils of participating schools were eligible to take part in the study (mean age = 8.9, *SD* = .7).[1] Consent forms describing the study procedures were sent home to parents of all children in the participating schools. Only those children whose parents did not object were enrolled in the trial.

Procedure

We initially aimed to randomly allocate participating classes to either an experimental group that would receive the intervention during the study or a waiting control group that would receive the intervention at the end of the study. This would require that all participating classes were equipped with moderate- to high-specification computer facilities to allow for installation and smooth running of the software for the intervention. The researchers who conducted visits to all participating schools to assess installed computer systems ascertained that only a certain number of classes were equipped with computers that met the specifications set in the intervention manual. Such computer limitations posed potentially significant risks to maintaining high-quality implementation of the intervention, hence we decided to use a quasi-experimental design and assigned classes with up-to-date computer systems to the intervention group, and all remaining classes to the waiting control group.

After allocating classes to the experimental or waiting control conditions, trained researchers visited all participating classes during November 2007 to provide a brief awareness session about the concept of bullying. This session covered the definition of bullying, the direct and relational forms that bullying can take and the difference between bullying victimization vs. conflicts among equally strong children. At the end of this session, children were asked to complete a baseline assessment (T0) that measured bullying behaviors (primary outcome), knowledge about bullying and coping strategies, and moral disengagement (secondary outcomes). Results on secondary outcomes are reported elsewhere (Watson et al., n.d.). One week after the baseline assessment, children in the intervention group received the program once a week for 30 minutes over three consecutive weeks, while children in the control group followed their normal curriculum. Researchers administered the baseline questionnaire battery to children of both groups at two follow-up assessments, one (T1) and four (T2) weeks after termination of the intervention.

The study was approved by the Ethical Committees of the University of Warwick and the University of Hertfordshire (UK), and the Bavarian and Hesse Ministry of Education (Germany).

Intervention

Children were introduced to a virtual school populated by 3D animated pupils who assumed the roles that

[1] In the UK school system children attend primary school for 6 years and are enrolled at 5 years of age. In Germany (Bavaria, Hesse), children enroll at 6 to 7 years of age and the primary school period is 4 years before selection to different streams of secondary school. Schools were reluctant to allow intervention for final year primary school students who attend exams.

children take while bullying occurs (i.e., victims, bullies, bystanders) to improvise real-life bullying incidents in a series of episodes that comprised a whole scenario, separate for each gender. The 3D agents (pupils) in this virtual school have artificial intelligence that enables them to learn from the victimization situations they experience and adjust their self-efficacy beliefs in response to these as they start to develop successful coping strategies in the course of the episodes (Aylett et al., 2006). The content of the episodes was adjusted to the characters' gender so that male episodes included more physical bullying and female episodes more relational bullying. After each episode in which an act of bullying occurred, an interactive episode followed in which the users (students) were allowed to interact with the virtual victim by typing in their coping suggestions to help them prevent further victimization (see Figure 1). Students had the opportunity to observe the outcome of their suggested strategy as the story emerged according to the advice given by the child, apart from when the victim character did not feel emotionally competent to follow the proposed strategy (i.e., did not feel strong enough to stand up to the bully), as could happen in real life. The success of each applied strategy depended on parameters adjusted to follow real- world probabilities from 0 (never successful) to 10 (always successful) that were devised by the research team based on previous research (Kochenderfer & Ladd, 2000; Mahady Wilton, Craig, & Pepler, 2000; Salmivalli, Karhunen, & Lagerspetz, 1996) and accounting for the nature of the bullying (direct or relational). A detailed description of the technological aspects of the English and German version of FearNot! is available elsewhere (Aylett et al., 2006; http://www.e-circus.org).

During the three-week intervention, children were asked to interact individually with the software for approximately 30 minutes each week. The interaction time was controlled for all students by a timer. Students were allocated to the same computer for each session, enabling them to follow the story at the point it was discontinued. All teachers received a manual that clarified their role during the implementation of the intervention. They were explicitly instructed to assist children only when they reported comprehension problems and to avoid providing help with coping strategies unless the child was experiencing difficulties in finding advice for the victim.

Measures

Demographics. Children reported their gender, age, number of siblings and with whom they lived at home, factors found to be related to bullying involvement (Olweus, 1993; Wolke, Woods, Stanford, & Schulz, 2001).

Class-level measures. *Class size* was the total number of enrolled students in each class. A dichotomous measure of *class socioeconomic status (SES)* was computed based on teachers' responses to a single item asking respondents to indicate the percentage of students in their class that were eligible for welfare benefits such as free school meals. Classes with less than 10% of students entitled to benefits were coded 1 (high SES).

Bullying involvement. Two questions adapted from Olweus (1993) enquired about the frequency of direct and relational victimization over the last month. Direct victimization included being hit/beaten up, having things stolen, being threatened/blackmailed, being called nasty names and having nasty tricks played on them. Relational victimization comprised how often they got left out of games, had children telling them they don't want to be their friend anymore or had nasty lies or rumors spread about them. Both items were rated on a 4-point scale: 'never,' '1–2 times,' 'more than 4 times,' and 'at least once a week.' Children were classified as *victims* if they had experienced either direct or relational bullying more than 4 times in the last month. They were further categorized as *escaped victims* if they reported being either directly or relationally bullied at baseline, but had experienced neither form of bullying at the first (T1 escaped victim) or the second follow-up (T2 escaped victim). Participants were also asked two questions about perpetrating direct and relational forms of bullying in the last month, using the same response format. They were categorized as *bullies* if they admitted to bullying others either directly or relationally more than 4 times during the last month. We combined direct and relational types of bullying into a single measure as, in the current longitudinal sample, 7.3% (n = 66) of children were identified as direct only victims, 6.4% (n = 58) as relational only victims and 11.2% (n = 102) self-reported being both direct and relational victims of bullying.

Figure 1 FearNot! screenshots of male verbal bullying episode and female making new friend user interaction episode (English version)

Implementation measure. Computer log files of users' inputs recorded the total amount of time each child interacted with the software (in seconds), the total number of episodes that enacted bullying incidents and the total number of interaction episodes (i.e., during which children were able to type in advice) for each child across the three sessions.

Semi-structured interviews with the teachers of the intervention classes (N = 23) were conducted by a member of the research team during the first follow-up assessment to obtain teachers' perspectives on their experience of implementing the intervention. Teachers were asked whether they had followed each of the five instructions (e.g., children interacted individually with the software, children returned to the same computer, the teachers supervised the sessions) in the teacher's manual ('never' = 1 to 'all the time' = 5; the sum of scores to these five questions was used for between-country comparisons), whether their class had used computers in the past ('never' = 1 to 'frequently' = 5), how they rated the software ('very poor' = 1 to 'very good' = 5) and whether they would consider using it again in the future ('definitely not' = 1 to 'definitely yes' = 5). They were also allowed to provide general comments on the intervention exercise.

Statistical analyses

To detect a 5% reduction in identified victims at 80% power in the intervention group compared to the control group, 152 victims needed to be included in each arm of the trial. At an assumed rate of 25% of self-reported victims in primary school, 1,216 children were required to be screened. To detect a 10% reduction in overall victimization at 80% power, 500 children needed to be included in the sample. All power analyses were performed with the PS shareware program (Dupont & Plummer, 1997).

We conducted analyses for the combined sample of countries and separately for UK and German pupils despite the lowered power for secondary prevention effects. Only those students with complete data at all three assessment points were included in the analysis. Intervention effects were analyzed using multilevel logistic regression models with HLM version 6.06 (Bryk, Raudenbush, & Congdon, 1996) to account for the hierarchical nature of the data (students nested within classes). Rates of children escaping victimization at follow-up 1 and 2 after having been subjected to repeated bullying at baseline were included in the analyses as the outcome for assessing secondary prevention effects. Victimization rates at follow-up 1 and 2 were the assessed outcome of primary prevention effects. Finally, the outcome variable for testing that the intervention did not increase bullying was bullying perpetration rates at follow-up 1 and 2. Baseline measures of outcomes (only in primary prevention analyses), gender and age were added as covariates in the models. Odds ratios were converted to relative risk using the method proposed by Zhang and Yu (1998). To assess the impact of the amount of active interaction with the FearNot!! characters on assessed outcomes, further multilevel logistic regressions within the intervention group were performed, controlling for gender and age.

Results

The flow of participants through the study is shown in Figure 2. Of the 1,178 children recruited to the study, n = 49 refused participation with a remaining initial sample of N = 1,129. Baseline questionnaires were returned by 94.7% (N = 1,069/1,129), 509 in the intervention group and 560 in the control group. At the first follow-up (T1), 91.9% (N = 1,038/1,129) of the initial sample was retained. The second follow-up (T2) assessment was completed by 1,047/1,129 children (response rate, 92.7%). The initial sample consisted of 52.1% (n = 563) males and 47.9% (n = 517) females. Mean age of children at baseline was 8.9 years (SD = .7). Among baseline victims, there were equal proportions of males and females (50.4% males vs. 49.6% females). Complete data at all three assessment points were available for N = 942/1,129 (83.4%; 455 in the intervention group and 487 in the control group) from the UK and Germany (n = 520 in the UK subsample and n = 422 in the German subsample). Mean age was higher for UK pupils (n = 514) than German pupils (n = 422) (9.36 vs. 8.34; t = 28.71; p <.001).

Allocation bias analysis

Allocation bias analysis indicated that participants in the intervention and control groups were comparable at baseline in terms of gender, age, living arrangements and family composition. Intervention and control classes were similar with respect to size and SES. Details are given in the online appendix Table S1.

Non-responder analysis

Non-responders at follow-up 1 were similar to completers in terms of gender, age, living arrangements, family composition and baseline victimization. Participants lost at follow-up 2 were significantly less likely than responders to be living with their mothers (90.6% vs. 98%; χ^2_1 = 13.68; p < .001) and younger (8.68 vs. 8.91; t = 2.41; p = .02) at baseline.

Prevalence of bullying behaviors

Across all time periods, there were fewer victims among the intervention group children compared with controls, but the difference was only statistically significant at the first follow-up (91 (20.8%) intervention vs. 127 (27.4%) control children; χ^2_1 = 5.43; p = .02). Both groups reported similar rates of bullying perpetration at all time points (Table 1). UK and German children experienced similar rates of victimization (28.6% vs. 23.6%; χ^2_1 = 2.82; p = .09). There was a significantly higher number of bullies among UK children than German children (99 (20.3%) vs. 15 (3.7%); χ^2_1 = 54.47; p < .001).

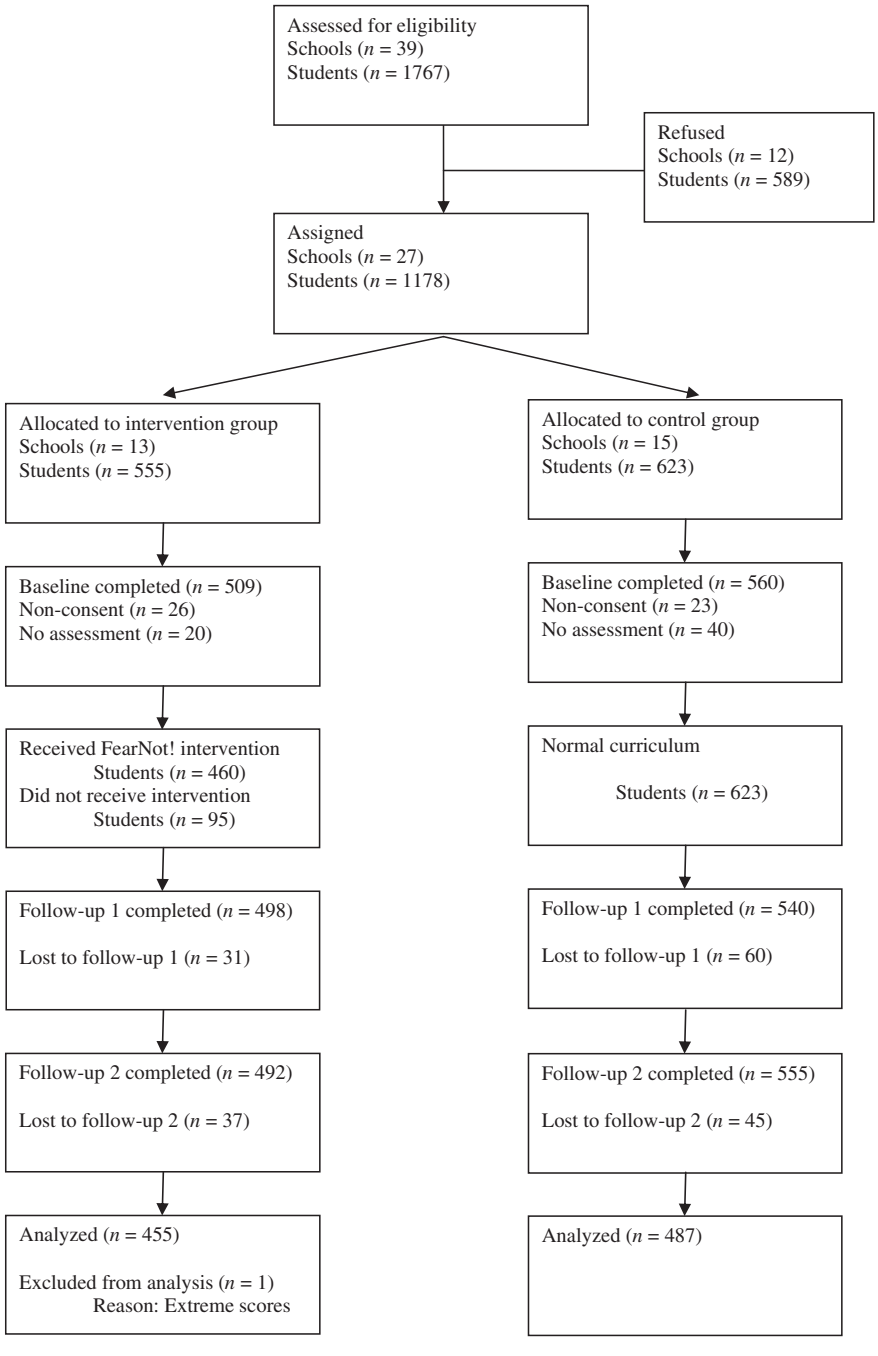

Figure 2 Participant flow diagram

Intervention implementation

Children in the intervention group watched on average 20.2 (*SD* = 12.1) episodes and interacted with the FearNot! characters during an average number of 10.5 (*SD* = 6.6) interaction sequences. Total time of interaction with the FearNot! software for intervention group children was 51.6 minutes (*SD* = 26.1). Children in the UK and Germany watched a similar number of episodes (20.9 vs. 19.4; t = 1.39; p = .17) and interacted with virtual victims during the same number of sequences (10.8 vs. 10.2; t = .99; p = .32). However, UK children interacted less time (in minutes) with the software than German children (46.3 vs. 57.7; t = –4.80; p < .001).

Teacher's reports of implementation fidelity showed that German teachers followed the implementation instructions more diligently than UK teachers (24.70 vs. 23.08, $F(1,21)$ = 6.128, p = .02) but expressed more ambivalent attitudes towards the software. Specifically, 40% (n = 4) of German teachers compared to 7.7% of UK teachers (n = 1) rated the software as very poor or poor and 70% (n = 7) said that they would definitely or probably not consider using the software again in their classes compared to only 15.4% (n = 2) of UK teachers. A qualitative investigation of teachers' comments about their experiences of using FearNot! revealed that although teachers in both countries faced technical problems during the implementation of the intervention (i.e.,

Table 1 Self-reported prevalence of victimization and bullying

Self-reported behavior	Experimental condition	
	Intervention %	Control %
Victimization		
Baseline	25.7 (109/424)	26.9 (128/475)
First follow-up*	20.8 (91/438)	27.4 (127/463)
Second follow-up	20.5 (88/429)	21.4 (101/471)
Bullying		
Baseline	11.3 (48/423)	14.1 (66/469)
First follow-up	10.8 (47/436)	11.8 (54/457)
Second follow-up	11.1 (48/434)	11.8 (55/465)

Note: Values represent percentages of students (*N*/total *N*).
*$p < .05$.

Table 2 Secondary prevention effects on escaped victimization

Outcome	Intervention group %	Control group %	Adjusted risk ratio (95% confidence intervals)
Escaped victimization at follow-up 1			
Total	50 (53/106)	35.5 (44/124)	1.41 (1.02–1.81)*
UK	52.5 (31/59)	27.3 (21/77)	1.90 (1.23–2.57)*
Germany	46.8 (22/47)	48.9 (23/47)	.96 (.58–1.37)
Escaped victimization at follow-up 2			
Total	53.8 (56/104)	50.4 (62/123)	1.06 (.76–1.36)
UK	49.1 (28/57)	43.4 (33/76)	1.10 (.66–1.56)
Germany	59.6 (28/47)	61.7 (29/47)	1.02 (.63–1.33)

Note: Values represent percentages of students (*N*/total *N*).
*$p < .05$.

software instability), German teachers were less experienced in using computers in their classes (20% of German teachers reported that their class had used computers frequently or very frequently compared to 100% of UK teachers) and, therefore, possibly faced more difficulties responding to technical problems considering also the lack of IT support provision in their schools.

Effects of intervention on escaped victimization rates across baseline victims

At the first follow-up, baseline victims in the intervention group were significantly more likely to escape victimization than were baseline victims in the control group (adjusted RR = 1.41, 95% CI: 1.02–1.81; n = 230) (Table 2). Out of 106 baseline victims in the intervention group, 53 (50%) managed to escape victimization at follow-up 1, compared to 44 out of 124 (35.5%) baseline victims in the control group. Further analyses within the baseline victims of the intervention group (n = 88/109 with complete data) revealed a significant dose–response relationship. Children who took part in a greater number of interaction episodes with the FearNot! characters were more likely to escape victimization at follow-up 1 (adjusted OR, 1.09; 95% CI, 1.003–1.18). A dose–response relationship was not found for total time of interaction with the software and total number of episodes watched. A significant treatment effect was not maintained four weeks after the intervention. Within-country analyses revealed a significant short-term treatment effect on escaped victimization only among UK baseline victims (Table 2). This effect was not related to total time of interaction with the software, number of episodes watched and number of interaction episodes participated in.

Effects of intervention on victimization rates across all students

Multilevel logistic regression results for the combined sample showed that after controlling for baseline experiences of victimization, gender and age, there was a trend towards a 26% decrease in victimization risk in the intervention group compared to the control group at follow-up 1 (adjusted RR, .74; 95% CI, .52–1.02; n = 864); however, this was not statistically significant. At follow-up 2, no differences were found in the rates of victimization between intervention and control group students (adjusted RR = .94, 95% CI: .67–1.27; n = 862). Further within-country analyses showed that UK children in the intervention group experienced significantly lower victimization rates at the first-follow up compared with controls (adjusted RR = .60, 95% CI: .36–.93; n = 470), but no effect was found in the German sample (Table 3).

Evaluation of potential adverse outcomes

The intervention did not significantly increase bullying rates among intervention group children compared with controls at follow-up 1 (adjusted RR = 1.05, 95% CI: .58–1.81; n = 853) and follow-up 2 (adjusted RR = .92, 95% CI: .52–1.55; n = 856). Results were confirmed in subsequent subsample analyses. Details are provided in the online appendix Table S2.

Discussion

To the best of our knowledge, this is the first controlled trial investigating the efficacy of an immersive virtual learning intervention for victims of bullying. In the combined sample, we found that the FearNot! intervention significantly increased the probability of baseline victims escaping victimization at the first follow-up assessment, especially among those children who interacted more with the virtual characters by actively exploring advice. This beneficial effect was confirmed in subsequent within-country analyses only among UK children. In addition, an overall effect on reducing victimization was found for UK children in the intervention group who experienced a lower rate of victimization than controls one week after treatment. Finally, we found no negative side

Table 3 Primary prevention effects on victimization

Outcome	Intervention group%	Control group %	Adjusted risk ratio (95% confidence intervals)
Victimization at follow-up 1			
Total	20.8 (91/438)	27.4 (127/463)	.74 (.52–1.02)
UK	20.5 (48/234)	32.8 (85/259)	.60 (.36–.93)*
Germany	21.1 (43/204)	20.6 (42/204)	1.02 (.61–1.59)
Victimization at follow-up 2			
Total	20.5 (88/429)	21.4 (101/471)	.94 (.67–1.27)
UK	23.3 (53/227)	25.4 (67/264)	.95 (.59–1.45)
Germany	17.3 (35/202)	16.4 (34/207)	1.02 (.62–1.59)

Note: Values represent percentages of students (N/total N).
*$p < .05$.

effects of the intervention in increasing bullying perpetration among students.

The observed effect of the FearNot! intervention on victimization across the population of baseline victims is consistent with findings from preliminary evaluations of computer-based interventions intended to modify aggressive behaviors and cognitions. Bosworth, Espelage, DuBay, Daytner, and Karageorge (2000) reported that a multimedia intervention containing anger-management, conflict-resolution and perspective-taking modules significantly reduced adolescents' beliefs supportive of violence and increased their intentions to use non-violent strategies. Another small-scale study found that a computer-based intervention incorporating attribution retraining components reinforced highly aggressive students' prosocial attributions although no effect on antisocial behavior was observed (Hobbs & Yan, 2008).

We suggest that the interaction with the FearNot! virtual victims enabled the user victim to learn effective strategies for dealing with bullying in the real world, at least in the short term. Previous research has suggested that providing children with effective coping strategies against bullying is a successful approach to reducing victimization (Cowie, 2000; O'Connell, Pepler, & Craig, 1999; Salmivalli, 1999). The dose–response relationship within the intervention group indicates that those more actively engaged with the characters, rather than those who passively watched a greater number of episodes, were more likely to escape victimization, supporting our interpretation. We speculate that the interaction with FearNot!, at least temporarily, boosted victimized children's self-confidence in their ability to deal with bullying as they vicariously experienced successfully responding to bullying in the virtual world.

There was a significant country effect for escaped victimization and overall victimization rates at the first follow-up between the intervention and control groups. The intervention led to lower victimization rates only among UK pupils who interacted as often with the characters as the German children but in less time. UK children were older, had more years of schooling and likely higher reading and writing skills to benefit from the advice given (i.e., spent more quality time) and were more experienced in computer use. It appears that German children interacted more with FearNot! because they needed more time to type in their suggestions, since our results show that, ultimately, German children watched the same number of episodes and participated in the same number of interaction episodes as UK children. Another explanation for the observed country effect might be the different ways in which teachers accepted and dealt with the intervention during the three-week intervention period. Qualitative assessments of FearNot! by the teachers who implemented the intervention revealed that German teachers expressed more ambivalent attitudes towards the intervention compared to UK teachers, in that they provided more negative ratings of the software and showed less willingness to use the software in future teaching sessions. Therefore, UK teachers might have found the software more relevant for bullying teaching purposes compared to German teachers, and they may have initiated more discussions about children's experiences of using FearNot!.

The lack of a sustained effect can be explained first of all by the short duration of the intervention. Reviews of anti-bullying interventions found that the most successful programs were those that lasted longer and were highly implemented (J.D. Smith, Schneider, Smith, & Ananiadou, 2004; P.K. Smith et al., 2003). Although we made every effort to include in the intervention group only those schools with the highest possible specification computers, a significant number of teachers still reported that their implementation efforts were hampered by the instability of the software on school computers and the majority of students in both countries interacted less than the originally allocated time of 90 minutes through the three sessions. Finally, it is possible that intervention effects could have been strengthened by integrating a teacher-led instruction component into the program to help children reflect on what they have learned. Multiple-component interventions such as whole-school approaches have been the most successful in reducing victimization (Vreeman & Carroll, 2007). However, if we had opted for this approach, we would not have been able to separate the impact of the virtual reality application from the effect of the teacher-led course.

This study has some limitations. First, allocation of classes to experimental conditions was not random owing to the lower than expected appropriate computer facilities in primary schools. However, baseline comparisons revealed no statistically significant differences between the intervention and control groups on the socio-demographic factors assessed. Second, the evaluated period between the pre- and post-intervention measures was relatively short. Third, our

measure of victimization was self-reported and, therefore, potentially subject to recall and over-reporting biases, although our prevalence rates were similar to those of previous studies (Williams, Chambers, Logan, & Robinson, 1996; Wolke et al., 2001). Fourth, subjects could not be blinded to treatment received, which is usual in psychosocial interventions.

The strengths of this study include the controlled trial design, the large sample size, the cross-national nature of the sample and the use of multilevel analysis that accounts for the clustering of variance within classes. In addition, all analyses adjusted for baseline levels of bullying victimization/perpetration. No serious threats to the internal validity of this study were found. The control and experimental groups were comparable with regard to socio-demographic characteristics and attrition was low. Finally, pilot studies had shown that students developed strong empathy with the victim and although knowing that the events were not real in the physical meaning of the word, they felt (i.e., immersed) with the victim as if the events were happening (Hall, Woods, Hall, & Wolke, 2007).

Conclusion

This is the first controlled trial to show that a virtual learning intervention that encouraged children to explore effective strategies against bullying can reduce victimization, especially among children who are already experiencing repeated aggressive victimization. This new approach is safe, engaging, and offers a low-cost and time-efficient way of coaching children for a range of different situations not easily controllable in the real world (Hall et al., 2007). However, our findings suggest that for virtual learning interventions to be effective, they need to be of appropriate duration, include booster episodes over time, and require appropriate reading and writing abilities and active engagement of the child. Future applications will have to explore whether virtual learning intervention is most suitable as an additional component within a wider anti-bullying curriculum.

Supporting information

Additional supporting information may be found in the online version of this article:

Table S1 Baseline student and class-level characteristics*

Table S2 Intervention effects on bullying rates

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Acknowledgements

This work was partially supported by the European Community (EC) and is funded by the eCIRCUS project IST-4-027656-STP with university partners Heriot-Watt, Warwick, Hertfordshire, Sunderland, Bamberg, Augsburg, Wuerzburg plus INESC-ID and Interagens. The authors are solely responsible for the content of this publication. It does not represent the opinion of the EC, and the EC is not responsible for any use that might be made of data appearing therein. Trial Registration: Clinical Trials Registry, NCT00597337.

We would like to thank all the children, teachers and schools for their participation. We would also like to thank Nimrita Bahia, Sophie Birch, Daniel Cox, and Sunil Sthanakiya for their help with data entry.

Dieter Wolke had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Key points

- Bullying victimization has negative effects on children's mental and physical health. Few prevention programs have shown significant reductions in victimization.
- This study evaluated an immersive virtual learning intervention that encouraged children to explore effective coping strategies against bullying victimization.
- The proposed program increased the probability of baseline victims escaping victimization and reduced overall victimization rates among UK children. Furthermore, the intervention did not increase bullying perpetration rates.
- Virtual learning interventions may constitute a useful component of future anti-bullying programs to amplify positive outcomes, especially for children who are already experiencing bullying victimization.

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Manuscript accepted 20 May 2009