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Article

Toxic Hazard?

The Challenge of Developing Theory- and Evidence-Based Messages for the Prevention of Child Poisoning Accidents

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Abstract

Child poisoning accidents are a serious public health problem that could significantly be reduced by adopting preventive measures. This raises the question of how communication campaigns can address caregivers to increase the likelihood of performing preventive behaviours that may reduce childhood accidents. To develop evidence-based interventions, we first developed a theory-based model for explaining the intention to prevent child poisoning accidents based on determinants of pre-existing models. The model was tested among a quota sampled survey of parents of children under seven years in Germany (Study 1, N = 1,013). The attitude towards preventing poisoning accidents and the perceived behavioural control (PBC) showed the strongest relationship with the intention. Furthermore, behavioural and control beliefs based on the Theory of Planned Behaviour (TPB) were identified and experimentally addressed in Study 2 (N = 550) to examine effects on attitude, PBC, and intention. Addressing these beliefs did not affect the dependent variables. However, there was a relationship between the respective beliefs, attitudes, and the PBC. Furthermore, attitude and PBC were strongly related to the intention. The results suggest that in the communication of child accident prevention, addressing the attitude towards preventive behaviour, the PBC, and risk perception may be useful.

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Keywords

Child poisoning prevention, messages, Germany, online survey, experiment.

Poisoning accidents in children are a significant health problem (Schwebel et al., 2017). Not only are children very susceptible to accidents, but also, once an accident happens, it can have serious consequences, especially for young children (Peden et al., 2008; Varnaccia et al., 2014). However, up to 50% of child accidents could be prevented through preventive measures (Spitzer & Höllwarth, 2015). In this context, caregivers (e.g., parents, grandparents) play an important role in accident prevention among toddlers and young children of preschool age who are not able to prevent themselves from having accidents. For that reason, it is important to keep caregivers well-informed about child accidents and ways to prevent them (Pathak et al., 2022). Accordingly, communication activities are an essential element in promoting preventive behaviours among caregivers (Friemel & Frey, 2019).

A theory- and evidence-based foundation is particularly crucial in planning effective and efficient communication campaigns. This is explicitly emphasised in previous research concerning childhood accidents (Ellsäßer et al., 2014; Stehr et al., 2022). Among other aspects, this involves deriving potentially effective message content based on social psychological behavioural theories (Hornik & Woolf, 1999; Rossmann, 2010). However, a lack of message content derived from theories still exists, especially for Germany and the specific target group of the caregivers of young children. Furthermore, campaign messages should not only be identified but also evaluated with regard to their effectiveness, which has been rarely done so far (Schneider Stingelin, 2018).

Within the framework of a comprehensive research project, we developed a theory-based model for explaining the intention to prevent child poisoning accidents. In the process, child injury prevention in general formed the broader scope of our research as the model fundamentally should not be limited to child poisoning accidents but also could be applicable to other preventable kinds of child injuries. In general, child accidents are easiest to prevent at a younger age, as accidents during the early developmental stage mostly happen at home, where parents have a direct influence on the safety of the environment (Spitzer & Höllwarth, 2020). Compared to other kinds of injuries like falls or traffic accidents, which occur mainly outside and more frequently with higher age of children, poisoning accidents rather affect younger children and mostly happen in the home environment (Schwebel et al., 2017; Spitzer & Höllwarth, 2020). Therefore, they could, in many cases, be prevented by parents, e.g., by locking poisonous substances like alcohol, medicine, household cleaners or chemicals away or putting them out of children's reach (Rosenberg et al., 2011). However, many child poisoning accidents still occur due to several reasons, e.g., relying on allegedly childproof packaging, underestimating the child's ability to climb to the top shelf or being unfamiliar with risks from new products like e-cigarette liquids or laundry pods (Schwebel et al., 2017). Hence, despite child poisoning accidents being preventable and controllable, better communication is crucial for accident prevention. Therefore, our studies specifically focus on child poisoning accidents as a use case.

The model that we developed was based on determinants from various models/theories that have been frequently used in the context of child injury prevention (Stehr et al., 2022). Initially, we validated the model in a preliminary qualitative study. Within the scope of Study 1, we then tested the model based on quantitative survey data to identify key behavioural determinants

and underlying beliefs. In summary, our study contributes to the theory- and evidence-based identification of message content to address the intention to adopt preventive behaviour in the context of child injuries. Furthermore, we do not only identify message content on a theoretical basis but also evaluate it regarding its effectiveness.

Literature-Based Theoretical Model

To comprehensibly explain caregivers' intention to adopt measures to prevent poisoning accidents, we established a model (see Figure 1) based on the current state of research in the context of child injury prevention. The main basis of the model is the Theory of Planned Behaviour (TPB, Ajzen, 1991)—a prominent framework to predict and explain behaviour in various domains as well as one of the most common theories applied in the context of injury prevention in children (Stehr et al., 2022; Steinmetz et al., 2016). The TPB states that attitudes, subjective norms, and perceived behavioural control (PBC) are important behavioural determinants. *Attitudes* refer to an individual's appraisal of whether performing a particular behaviour would be beneficial (Ajzen, 1991). Previous studies have shown that attitudes predict the intention to implement preventive measures (e.g., Gielen et al., 1984; Vladutiu et al., 2006). Accordingly, e.g., Chung-Park (2012) showed that parents' attitudes are significantly related to the practice of safe sleeping position behaviours.

Subjective norms refer to the notion that important others want one to perform a particular behaviour and comprise descriptive norms (important others do engage in the behaviour) and injunctive norms (the perceived pressure from significant others to perform the behaviour) (Ajzen, 1991). Mello and Hovick (2016) showed that greater perceived norms are associated with parents' stronger engagement in reducing their children's exposure to toxic chemicals. Furthermore, Beirens et al. (2010) found that the descriptive norm is a strong predictor for storing poisonous products safely.

Perceived behavioural control (PBC) describes to what extent someone feels able to perform a behaviour (Ajzen, 1991) and is positively related to the intention to adopt preventive behaviour. Based on the comparable construct of self-efficacy from the Protection Motivation Theory (PMT, Rogers, 1983; Rogers & Prentice-Dunn, 1997), Beirens et al. (2010) showed that parents' perceived ability to store medications and cleaning products out of reach of their children is significantly related to protection behaviours. To sum up, we assume positive relations of parents' attitudes towards the prevention of child poisoning (H1), subjective norms (H2), and perceived behavioural control (H3) with the intention to adopt preventive behaviour.

Although the three core dimensions from TPB already explain a large part of the behaviour, they lack an aspect that is crucial in health and risk contexts. Referring to the Health Belief Model (HBM, Rosenstock, 1974) and the PMT (Rogers, 1983; Rogers & Prentice-Dunn, 1997), *risk perceptions* play an important role in explaining such behaviours. In the context of poisoning prevention, the relationship between risk perceptions and the intention to adopt preventive behaviour has been shown in several studies (e.g., Beirens et al., 2010; Shahkolai et al., 2019). Accordingly, Rosenberg et al. (2011) found that the uptake of poisoning prevention strategies was significantly related to the perceived susceptibility and severity of poisoning from different common household products. As risk perceptions are often related to affective responses (Hubner & Hovick, 2020; Kahlor, 2010), we included both constructs in our model explaining the intention to prevent poisoning accidents. To summarise, we assume a positive relation between risk perceptions and affective reactions (H4) and positive relations

of both constructs with the intention to adopt preventive behaviour (H5, H6).

Risk perceptions may not only have an influence on the intention to adopt preventive behaviour but also on the attitude. Accordingly, Mello and Hovick (2016) showed that risk perceptions are significantly related to mothers' attitudes towards poisoning prevention. Hence, we include this relation into our model (H7).

In addition to those model-based determinants, we decided to include another potential predictor from the specific literature on child injury prevention: perceived preventability. Parents may perceive their children's possible accidents as unpreventable or even a necessary and valuable lesson while growing up, especially for male children (Morrongiello et al., 2010). Therefore, according to Morrongiello (2018), preventability is a relevant factor that influences parents' intentions to prevent injuries in children. Consequently, we predict that the perceived unpreventability is negatively related to the intention to adopt preventive behaviour (H8).

According to the TPB (Ajzen, 2020), the determinants of a particular behaviour are based on underlying beliefs. Accordingly, attitude towards a behaviour is determined by behavioural beliefs concerning negative and positive outcomes of performing a particular behaviour. Furthermore, the subjective norm is influenced by normative expectations of significant reference groups. Finally, PBC is assumed to be based on control beliefs that include factors that either facilitate or impede performing a specific behaviour. In general, identifying the underlying beliefs can be valuable as those can be directly addressed, e.g., in campaign messages (Rossmann, 2013). Therefore, in addition to the previous hypotheses that explain the intention to prevent poisoning accidents, we were also interested in 1) identifying the underlying beliefs that influence the behavioural determinants of preventive behaviour and 2) addressing them experimentally in Study 2. Therefore, in Study 1 we pose the research question *RQ1: What a) behavioural beliefs, b) control beliefs, and c) normative reference groups relate to the intention to prevent poisoning accidents?*

Pre-Study: Qualitative Evaluation of the Theoretical Model

Within the larger project, we conducted online focus groups with 42 caregivers (details on the method are published elsewhere in Stehr et al., 2023a, 2023b). We used this data to a) evaluate the adequacy of our theoretical model and b) examine the specific underlying beliefs for our topic. The interview data revealed no additional behavioural determinants not already included in the model. However, it highlighted the importance of not only including risk perceptions but also affective risk reactions. Moreover, the qualitative pre-study underlined that knowledge is a background factor of several constructs, including risk perceptions and behavioural beliefs. Hence, we stuck with the decision not to include knowledge as a separate predictor into the model. In addition, the pre-study showed that perceived (un)preventability is hard to be allocated within the model. While some of the caregivers' statements associated preventability with the appraisal of the behaviour (attitude/should all injuries be prevented?) others referred to accidents as unavoidable (perceived control/can all injuries be prevented?). Therefore, we included unpreventability as a separate determinant into the model (see Figure 1). The behavioural beliefs, control beliefs, and normative reference groups for preventing poisoning accidents in children elicited within the focus groups were used to operationalize them within Study 1 and Study 2.

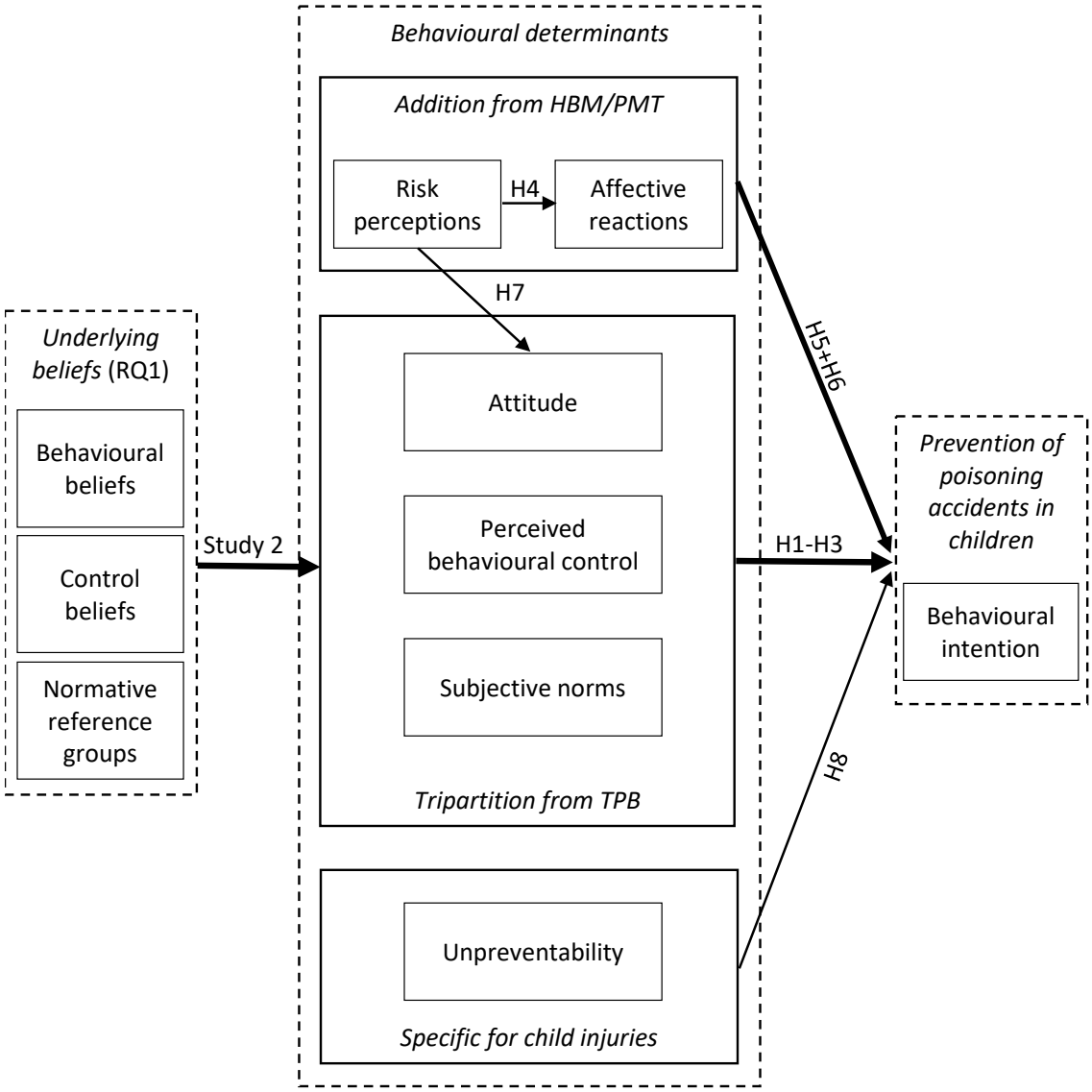

Figure 1. Theoretical Model Including the Hypotheses and Research Questions of Study 1 and the Research Interest of Study 2

Study 1: Quantitative Evaluation of the Theoretical Model

Methods

Participants and Procedures. Before data were collected, the university's ethics committee approved the study. To test our hypotheses, we conducted an online survey of N = 1,013 parents living in Germany with children under seven years in September 2021. Participants were recruited via an online access panel provider. The quota sample was representative of our target group regarding sex and education (see Table 1): 58.6% female and 41.4% male; 58.5% did not have a formal educational degree or had lower education, 17.3% had higher education entrance qualification, and 24.2% had a university degree. Participants' ages varied between 20 and 65 years (M = 36.5, SD = 6.8). The mean age of the youngest child was 2 years and 11 months (M = 3.0 years, SD = 1.8).

Table 1. Descriptive Sample Analyses of Both Studies

	Study 1		Study 2	
	M	*SD*	*M*	*SD*
Age	36.5	6.8	37.2	7.6
	n	%	n	%
Sex				
Female	594	58.6	285	51.8
Male	419	41.4	264	48.0
Education				
Low	593	58.5	262	47.6
Medium	175	17.3	131	23.8
High	245	24.2	157	28.5

Note. $N_{Study\ 1}$ = 1,013; $N_{Study\ 2}$ = 550.

Measures. The online survey was based on validated scales and the results of the qualitative pre-study (see Supplementary Material Appendix 1 for the questionnaire). All items were measured using 5-point Likert scales. The dependent variable, namely the *intention to adopt preventive behaviour*, was measured by nine items that covered different types of poisoning prevention behaviours (*M* = 4.3, *SD* = 0.7, 1 = *does not apply at all*, 5 = *fully applies*) based on different studies and information material on poisoning prevention (Bundesinstitut für Risikobewertung, 2021; Desel & Woelk; Forjuoh, 2016; Rosenberg et al., 2011). For the calculation of the mean index, only the items applicable to each individual case were included.

According to Ajzen (1991), the attitude towards a specific behaviour, the subjective norm, and the perceived behavioural control can be measured on a belief-based scale, e.g., comprising beliefs derived from preliminary pilot studies. Therefore, the *attitude towards preventive behaviour* (*M* = 3.8, *SD* = 0.7, 1 = *very unlikely*, 5 = *very likely*) was captured by eight items comprising the different dimensions of behavioural beliefs that were identified in the preliminary qualitative study (e.g., increased child's autonomy, fewer injuries). Due to the low average variance extracted (AVE), items for attitude were included in the model as a hierarchical reflective measurement model (Hair et al., 2017, p. 238) composed of negative and positive behavioural consequences (see Table 2). The *perceived behavioural control* (PBC) (*M* = 3.6, *SD* = 0.7, 1 = *does not apply at all*, 5 = *fully applies*) was measured with five items on different dimensions of control beliefs also adopted from the preliminary qualitative study (e.g., lack of knowledge, social support). As for the attitude, due to low AVE, the PBC was calculated as a hierarchical reflective measurement model (Hair et al., 2017, p. 238) composed of barriers and facilitators. Regarding the *subjective norm towards preventive behaviour* (*M* = 4.3, *SD* = 0.7, 1 = *not good at all*, 5 = *very good*), participants were given a list of nine normative reference groups that were named as the most important reference groups in the preliminary qualitative study (e.g., their partners, physicians). Then, they were asked about the opinions of these reference people concerning the participant implementing all given measures to prevent poisoning accidents.

The *unpreventability of poisoning accidents* was measured by three items addressing fatalistic beliefs concerning the prevention of poisoning accidents, adapted from Niederdeppe and Levy (2007). Due to low factor loadings, two items had to be excluded. Therefore, unpreventability was included in the model as a single item (*M* = 2.8, *SD* = 0.8, 1 = *strongly disagree*, 5 = *strongly agree*). To capture the *risk perception*, the *perceived susceptibility*

(*M* = 2.1, *SD* = 1.0, 1 = *not probable*, 5 = *very probable*) and *severity* (*M* = 3.6, *SD* = 1.1, 1 = *not severe at all*, 5 = *very severe*) of participants' child having a poisoning accident were measured as in Mello and Hovick (2016). These two dimensions were integrated as single items into the data analysis. *Negative affective reactions* (i.e., anger, fear, sadness, guilt, shame/shyness, and worry) (*M* = 3.3, *SD* = 0.9, 1 = *does not apply at all*, 5 = *fully applies*) were based on the German translation (Merten & Krause, 1993) of Izard's (1982) Differential Affect Scale and were calculated as a hierarchical reflective measurement model (Hair et al., 2017, p. 238).

Data Analysis. We tested our hypotheses using structural equation modelling following the PLS approach (Hair et al., 2017). The analysis was performed by using SmartPLS3 (Ringle et al., 2015). First, the internal consistency of the reflective measurement models was evaluated by reviewing the indicator reliability (factor loading ≥ .60, Bagozzi & Yi, 1988; Weiber & Mühlhaus, 2014) and the composite reliability (≥ .70, Chin, 1998; Hair et al., 2017) as well as the convergent validity based on the average extracted variance (AVE ≥ .50, Fuchs, 2011; Hair et al., 2017). All final measurement models showed satisfactory results (see Table 2).

We also ensured the discriminant validity of the reflective measurement models by controlling for the Fornell–Larcker criterion (Fuchs, 2011). According to this criterion, the square root of the average variance extracted by a construct must be greater than the correlation between the construct and any other construct. Additionally, we checked for multicollinearity among variables. VIF values were within the acceptable thresholds (VIF < 5; Hair et al., 2017). A correlation matrix of the behavioural determinants can be found in the supplementary material (Appendix 7). After validating the quality criteria of the measurement models, we computed the actual structural model to determine its explanatory power and test our hypotheses. To answer the research question, beliefs were regressed on the intention to adopt preventive behaviour using IBM SPSS Statistics (Version 27). Those beliefs were to be subsequently addressed in the communication materials to be tested in Study 2.

Table 2. Quality of the Reflective Measurement Models

Construct	Factor Loading (≥.60)	AVE (≥.50)	Composite Reliability (≥.70)
Attitude		.62	.76
Positive behavioural consequences	.93		
Negative behavioural consequences	.62		
PBC		.62	.77
Facilitators	.89		
Barriers	.68		
Negative affective reactions		.62	.91
Anger	.74		
Fear	.85		
Sadness	.85		
Guilt	.84		
Shame/shyness	.64		
Worry	.79		

Note. AVE = average variance extracted, PBC = perceived behavioural control.

Results

Prevention Behaviour Intention Model. Overall, the path model explained 21% of the variance in the intention to adopt preventive behaviour (see Figure 2). In line with H1, the attitude towards the prevention of child poisoning accidents ($b^* = .33$, $p < .001$) was positively related to the intention to adopt preventive behaviour. Contrary to H2, no significant relationship between the subjective norm and the intention to adopt preventive behaviour could be found ($b^* = .04$, $p = .322$). However, the PBC was significantly related to the intention to adopt preventive behaviour (H3) ($b^* = .14$, $p < .001$). Furthermore, H4 could only partly be supported: while a positive relationship between the perceived severity and the negative affective reactions could be observed ($b^* = .19$, $p < .001$), no significant relationship for the perceived susceptibility was found ($b^* = .03$, $p = .864$). As postulated in H5, there was a positive relationship between the affective reactions and the intention to adopt preventive behaviour ($b^* = .10$, $p = .001$). The relationship between risk perceptions and the intention to adopt preventive behaviour (H6) could only be supported for the perceived severity ($b^* = .12$, $p < .001$) but not for the perceived susceptibility ($b^* = –.01$, $p = .864$). Moreover, H7 could also only be supported for the relationship between severity and the attitude towards the prevention of child poisoning ($b^* = .20$, $p < .001$) since the relation for susceptibility was negative ($b^* = –.08$, $p = .043$). Finally, a positive relationship between the perceived unpreventability of child poisoning accidents and the intention to adopt preventive behaviour was found within the model ($b^* = .09$, $p = .006$), which contradicts H8.

Underlying Beliefs. As subjective norms did not significantly relate to the intention to adopt preventive behaviour, only the underlying beliefs for the two strongest predictors, i.e., attitude and PBC, were further analysed. Therefore, to answer the research question, behavioural and control beliefs were regressed on the intention to adopt preventive behaviour. Regarding the behavioural beliefs that were significantly related to the intention to adopt preventive behaviour, both positive and negative consequences could be identified. Positive consequences that were significantly related to the intention to adopt preventive behaviour were more safety ($b^* = .21$, $p < .001$), fewer injuries ($b^* = .18$, $p < .001$), more autonomy/freedom for the child ($b^* = .07$, $p = .036$), and less fear for the parents ($b^* = .07$, $p = .039$). Regarding negative consequences, more effort due to unnecessary measures ($b^* = –.08$, $p = .025$) and concern about becoming too overcautious ($b^* = .12$, $p < .001$) significantly affected the intention to adopt preventive behaviour (see Table 3).

Regarding the control beliefs, factors were identified that could inhibit or facilitate the implementation of preventive behaviour. Significant barriers were a lack of knowledge ($b^* = .12$, $p < .001$), a lack of time ($b^* = –.08$, $p = .025$), and stress/distraction ($b^* = –.07$, $p = .040$). In contrast, social support ($b^* = .13$, $p < .001$) turned out to be a significant facilitator of control beliefs (see Table 4).

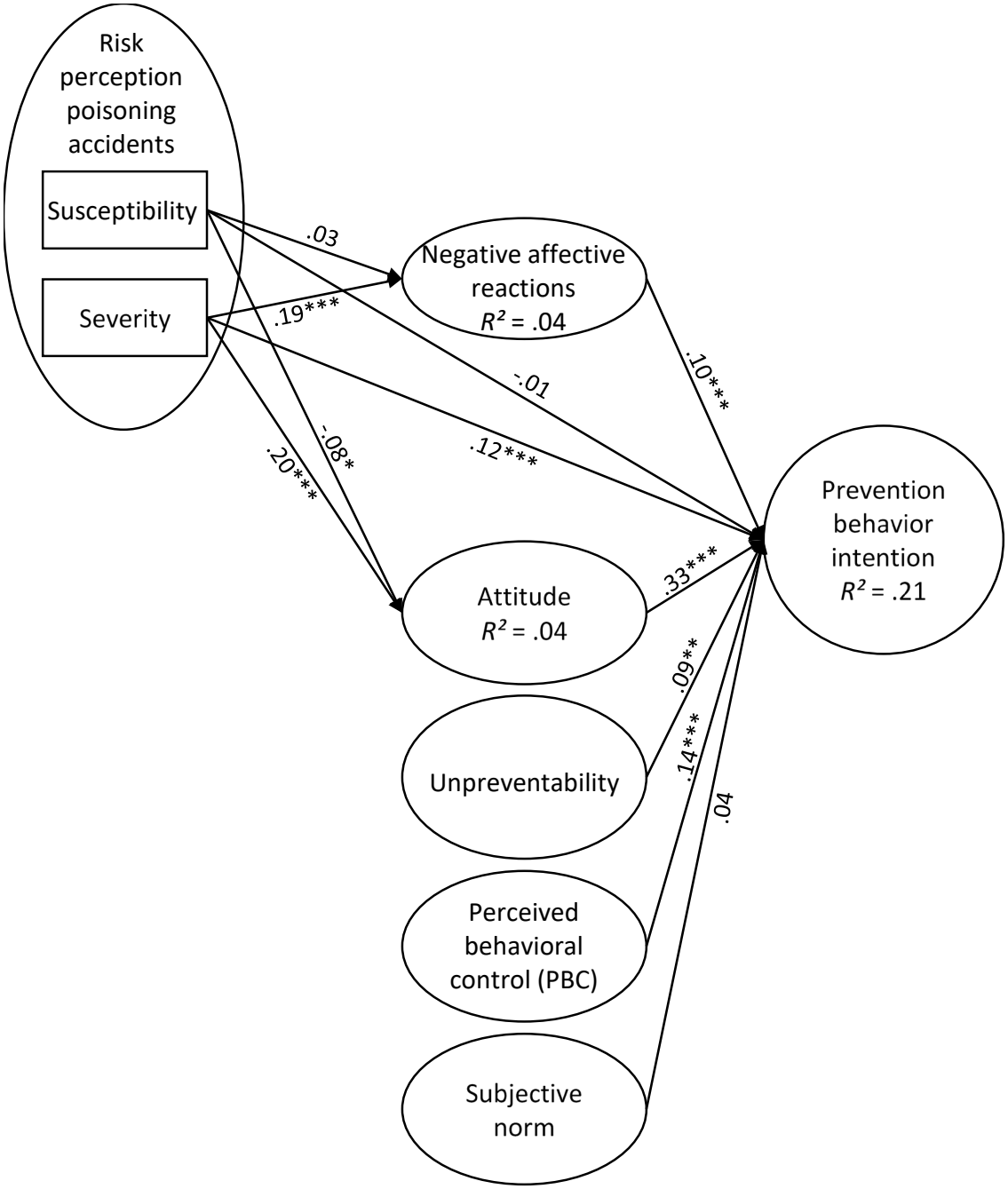

Figure 2. Path Model Study 1

Note. n = 1,013. PLS-Bootstrapping Approach with 5,000 subsamples.

*p < 0.5, two-tailed. **p < .01, two-tailed. ***p < .001, two-tailed.

Table 3. Multiple Regression of Behavioural Beliefs on Intention to Adopt Preventive Behaviour

	B	*SD*	β	*T*	*p*
By means of the aforementioned preventive behaviours …					
… my child is better protected in everyday life.	.16	0.03	.21	5.70	< .001
… my child will suffer fewer injuries.	.08	0.02	.12	3.37	< .001
… my child can move more independently in their environment.	.05	0.02	.07	2.10	.036
… I will be less afraid of poisoning accidents in everyday life.	.05	0.02	.07	2.07	.039
… I have a great effort for actually unnecessary measures.	−.05	0.02	−.08	−2.25	.025
… my child does not learn from their own experiences.	−.02	0.02	−.03	−0.97	.333
… my child's development will be restricted.	−.02	0.03	−.03	−0.81	.416
… I get too overcautious.	.07	0.02	.12	3.38	< .001

Note. N = 1,013, R^2 = .19; $F(8, 982) = 29.63$, $p < .001$.

Table 4. Multiple Regression of Control Beliefs on Intention to Adopt Preventive Behaviour

	B	*SD*	β	*T*	*p*
I do not have enough knowledge about poisoning prevention to prevent accidents.	.08	0.02	.12	3.77	< .001
I receive sufficient information to be able to prevent poisoning accidents.	−.03	0.02	.04	1.40	.162
I have people who support me in preventing poisoning accidents.	.07	0.02	.13	4.09	< .001
I do not have time to deal with the prevention of poisoning accidents.	−.05	0.02	−.08	−2.24	.025
Stress and distractions in everyday life make it difficult for me to prevent poisoning accidents.	−.04	0.02	−.07	−2.06	.040

Note. N = 1,013, R^2 = .09; $F(5, 1000) = 20.82$, $p < .001$.

Discussion

The results of Study 1 show that the attitude towards the prevention of child poisoning accidents and the PBC are significantly related to the intention to adopt preventive behaviour. Thus, our findings support the results of previous research that has empirically confirmed the relations between the attitude, the PBC, and the intention to adopt preventive behaviour (Chung-Park, 2012; Gielen et al., 1984; Vladutiu et al., 2006), which are postulated in the TPB (Ajzen, 1991). However, no significant relationship for the subjective norm was observed. In previous studies that have empirically tested the TPB, the effect of the subjective norms has also been found to be small or not significant (Manning, 2009; Stehr et al., 2021). Our study provides another hint that the influence of subjective norms on the behavioural intention does not seem highly relevant for some behaviours. Therefore, in Study 2, we focused on investigating the attitude towards the prevention of child poisoning accidents and the PBC and the respective significant underlying beliefs.

A further determinant of the intention to adopt preventive behaviour was risk perception. The tested path model shows that there is a direct relationship between risk perception (at least severity) and the intention to adopt preventive behaviour. Risk perception was also found to be indirectly related to the intention to adopt preventive behaviour through negative affective reactions and the attitude towards the prevention of child poisoning accidents. These results indicate that risk perception is a relevant determinant for addressing preventive behaviour. For that reason, in the experiment in Study 2, we consistently addressed risk perception in all groups and control it as a covariate. In contrast, susceptibility was not significant for all hypotheses. A possible explanation for these results may be the topic of our study: the mean values of susceptibility were relatively low compared to the mean values of severity. In combination with the relatively high mean value of the intention to adopt preventive behaviour, it seems possible that our sample is already familiar with the prevention of child poisoning accidents. An examination of the individual intention items further revealed that not only the mean index but also all individual items included in the index are skewed. Accordingly, our participants may already have implemented some of the addressed preventive measures so that they consider the susceptibility as rather low.

Furthermore, the results showed a significant but small relationship between the unpreventability of poisoning accidents and the intention to adopt preventive behaviour. It must be noted that the scale we transferred from fatalistic cancer beliefs to measure unpreventability of child injuries did not work and we only included unpreventability as a single item. Future studies should explore better ways to measure unpreventability in the context of child injuries. Moreover, the pre-study had already shown that this construct is hard to place within a TPB-based model because it includes attitudinal (should all accidents be prevented?) as well as control aspects (can all accidents be prevented?). For the control aspect, a construct such response efficacy that stems from the PMT (Rogers & Prentice-Dunn, 1997) may be better suited. In sum, the path model only explained 21% of the variance in the intention to adopt preventive behaviour. Hence, it must be considered that there may be other relevant determinants that have not been included in the model, e.g., habits (Bruijn et al., 2009).

In summary, in the previous part, we derived potentially effective message content on a theoretical basis. Since the identification of message content alone is not sufficient to ensure its effectiveness in campaigns (Noar, 2006), we evaluated the identified message content in a second step. For this purpose, we conducted an experiment to test the effectiveness of

activating the identified behavioural and control beliefs via messages to increase the behavioural intention. Furthermore, as negative affective reactions and risk perception (at least severity) were found to be significantly related to the intention to adopt preventive behaviour, both constructs were controlled as covariates in Study 2.

Study 2: Experimental Testing of Addressing Underlying Beliefs

Based on the results of Study 1, we addressed the identified underlying beliefs of the two strongest predictors of behavioural intention, namely attitude towards preventive behaviour and PBC, in more detail. Those beliefs that were significantly related to the intention to adopt preventive behaviour in Study 1 were addressed in the communication materials to be tested in Study 2.

We aimed to examine to what extent addressing the identified theory- and evidence-based a) behavioural beliefs and b) control beliefs does affect i) the attitude towards the prevention of child poisoning, ii) the PBC, and iii) the behavioural intention.

As explained previously, the TPB assumes that the attitude towards a specific behaviour is based on accessible behavioural beliefs (Ajzen, 2020). Therefore, we posed the following hypothesis:

> *H1a: When behavioural beliefs are addressed in the stimulus, the attitude towards preventive behaviour is more positive compared to when behavioural beliefs are not addressed.*

Moreover, the TPB assumes that the PBC is based on accessible control beliefs (Ajzen, 2020). Accordingly, we posed the following hypothesis:

> *H1b: When control beliefs are addressed in the stimulus, the PBC is higher compared to when control beliefs are not addressed.*

According to the TPB, the beliefs (in our case behavioural and control beliefs) are, ultimately, related to the behavioural intention (Ajzen et al., 2018). The results of Study 1 show that both behavioural beliefs and control beliefs were significantly related to the intention to adopt preventive behaviour. Based on these results, we posed H2a and H2b to investigate the main effects of behavioural and control beliefs on the intention to adopt preventive behaviour. Subsequently, we posed H2c to test a possible interaction effect of behavioural and control beliefs on the intention to adopt preventive behaviour.

> *H2a: When behavioural beliefs are addressed in the stimulus, the behavioural intention is stronger compared to when behavioural beliefs are not addressed.*
>
> *H2b: When control beliefs are addressed in the stimulus, the behavioural intention is stronger compared to when control beliefs are not addressed.*
>
> *H2c: When behavioural beliefs and control beliefs are both addressed in the stimulus, the behavioural intention is highest.*

Following the assumptions of the TPB, the effects of the beliefs, namely behavioural and control beliefs, on the behavioural intention are mediated by the attitude and the PBC (Ajzen et al., 2018). For that reason, we posed two partial mediation models in the following hypotheses:

H3a: The effect of the behavioural beliefs on the behavioural intention is partially mediated by the attitude towards preventive behaviour.

H3b: The effect of the control beliefs on the behavioural intention is partially mediated by the perceived behavioural control (PBC).

The experiment was preregistered at AsPredicted before the start of data collection (see https://aspredicted.org/MVW_6YJ).

Methods

Sample. An a priori power analysis with G*Power (Faul et al., 2007) was performed for sample size estimation. As G*Power does not offer a power analysis for a multivariate analysis of covariance (MANCOVA), sample size estimation was performed for multivariate analysis of variance (MANOVA) and analysis of covariance (ANCOVA). To detect an effect of $f^2 = 0.02$ with 80% power in a two-way between-subjects MANOVA (four groups, $\alpha = .05$, two predictors, three response variables), a minimum sample size of $N = 344$ was suggested. To detect an effect of $f^2 = 0.14$ with 80% power in a two-way between-subjects ANCOVA (four groups, $\alpha = .05$, two predictors, eight covariates), a minimum sample size of $N = 403$ was suggested. Therefore, a minimum sample size of $N = 403$ was aimed for Study 2. To ensure that the minimum sample size could be achieved even when cases were excluded during data cleansing (e.g., due to response pattern), a sample size of $N = 500$ (with a maximum of 10% over-recruitment) was aimed for Study 2. Based on the exclusion criteria defined in the preregistration, $n = 261$ cases were excluded by the panel provider. Minor deviations from the intended sample size are possible due to the online panel provider's software to achieve representative quotation regarding the sex and the education level of the participants.

Finally, the sample of our online experiment included $N = 550$ parents living in Germany with children under seven years, as no further cases needed to be excluded based on additional criteria in data cleansing (e.g., response patterns). Participants were recruited through the online access panel provider Respondi, and the sample was quoted with regard to the characteristics of sex and education level according to the distribution among parents of children under seven years. Accordingly, 51.8% of the participants were female, and 48.0% were male (see Table 1). The majority did not have a formal educational degree or had lower education levels (47.6%), 23.8% had a high-school diploma, and 28.5% had a higher education entrance qualification or a university degree. Participants were 19 to 78 years old ($M = 37.3$, $SD = 7.4$). The mean age of the youngest child was 2 years and 11 months ($M = 2.9$ years, $SD = 1.7$).

Measures. For the online experiment, participants ($N = 550$) were interviewed using an online survey with closed-response options based on previously validated scales and findings from the preliminary qualitative study (see Supplementary Material Appendix 2 for the questionnaire). Unless stated otherwise, all items were measured on 5-point Likert scales.

Dependent Variables. The dependent variables were considered the intention to adopt preventive behaviour, PBC, and attitude toward the prevention of child poisoning accidents.

As in Study 1, the *intention to adopt preventive behaviour* was measured by asking participants to rate the likelihood of implementing nine given preventive measures against poisoning accidents in the following three months ($M = 4.2$, $SD = 0.7$, 1 = *does not apply at all*, 5 = *fully applies*). In contrast to study 1, *perceived behavioural control* (PBC) was

measured based on Ajzen (2006) by asking participants first to rate whether they feel able to implement preventive measures against poisoning accidents in the next three months (1 = *not agree at all*, 5 = *totally agree*). Furthermore, participants were asked to rate to what extent they have control over implementing preventive measures against poisoning accidents in the next three months (1 = *not agree at all*, 5 = *totally agree*). An index was built out of the two items ($M = 4.6$, $SD = 0.7$). Compared to the operationalisation in Study 1, a different operationalisation of PBC was required here, beyond measuring it through beliefs, in order to examine the PBC independently of the control beliefs within the mediation analyses in Study 2. Similar to the PBC, *attitude towards the prevention of child poisoning accidents* was measured by asking participants to rate their attitude towards implementing all preventive measures on a 5-point semantic differential between five pairs of adjectives ($M = 4.4$, $SD = 0.6$, *unpleasant – pleasant*, *not helpful – helpful*, *annoying – not annoying*, *bad – good*, *not useful – useful*). Our scale is based on Kahlor (2007) and the recommendations of Ajzen (2006) for measuring TPB constructs in survey studies.

Covariates. As in Study 1, perceived *susceptibility* ($M = 1.9$, $SD = 0.9$, 1 = *not probable*, 5 = *very probable*) and perceived *severity* ($M = 3.3$, $SD = 1.1$, 1 = *not severe*, 5 = *very severe*) were measured to capture *risk perception*. An index was built out of the two items ($M = 2.6$, $SD = 0.7$). For *affective reactions*, the negative affective reactions from Study 1, based on the German translation (Merten & Krause, 1993) of Izard's (1982) Differential Affect Scale, were supplemented by two items covering the affect "worry" ($M = 3.2$, $SD = 0.9$). *Previous experience with child accidents* was measured by two items that participants could agree or disagree with. The participants should state whether they professionally or voluntarily work in the field of child safety. Furthermore, participants should state whether their child has ever had a poisoning accident. *Behavioural beliefs* were measured by six items asking participants how likely it would be that the given positive and negative consequences would occur when implementing all preventive measures in the next three months that have been mentioned before ($M = 4.1$, $SD = 0.7$, 1 = *not likely at all*, 5 = *very likely*). Those items were included to measure the behavioural beliefs in Study 2 that were significantly related to the intention to adopt preventive behaviour in Study 1. *Control beliefs* were measured by asking participants to rate to what extent three items applied to them ($M = 3.9$, $SD = 0.8$, 1 = *not at all likely*, 5 = *very likely*). As described for behavioural beliefs, those items were included to measure the control beliefs in Study 2 that were significantly related to the intention to adopt preventive behaviour in Study 1.

Procedure. An online experiment was conducted using a 2 x 2 between-subjects design (behavioural beliefs: addressed vs. not addressed and control beliefs: addressed vs. not addressed) in January and February 2022. An attention check was included in the questionnaire.

Each participant was randomly assigned to one of the four groups. Participants in each group received a text with identical general information concerning child poisoning accidents that addressed the prevalence of poisoning accidents, common causes of accidents, and severity of poisoning accidents (see Supplementary Material Appendices 3-6 for stimulus texts). As severity was found to be significantly related to the intention to adopt preventive behaviour in Study 1, risk perception was kept constant for all experimental groups by addressing it in the text with general information on child poisoning accidents. In addition to that, participants received a text that either addressed behavioural beliefs (behavioural beliefs condition), control beliefs (control beliefs condition), or a combination of both beliefs (combined condition)

according to their experimental condition. In each of the texts addressing the beliefs, we included those beliefs that emerged as significant behavioural or control beliefs in Study 1. Participants in the control group did only receive the text with general information and no further information on the beliefs.

Before starting data collection, a pre-test was conducted to test the technical functionality, comprehensibility, and success of the manipulation by the stimulus materials.

Data Analysis. For data analysis, IBM SPSS Statistics (Version 27) was used. After data cleansing, the final sample consisted of $N = 550$ participants.

First, we conducted two ANOVAs to evaluate to what extent the perception of the beliefs differed between the experimental groups after reading the stimuli. To test H1 and H2, we conducted a MANCOVA that included the three dependent variables (intention to adopt preventive behaviour, PBC, and attitude towards the prevention of child poisoning accidents). The independent variables were the message content, i.e., the behavioural beliefs (addressed vs. not addressed) and the control beliefs (addressed vs. not addressed). Risk perception, affective reactions, age, sex, education level of the participant, previous experience with child accidents, and age of the (youngest) child were observed as covariates. Negative affective reactions and risk perception were controlled as covariates as they were significantly associated with the intention to adopt preventive behaviour in Study 1. We observed the main effects for H1a, H1b, H2a, and H2b. For H2c, we observed the interaction effect between the two experimental factors. To test hypothesis 3, we conducted two mediation analyses using Hayes Process Model 4.

Results

As described above, we conducted one ANOVA for the behavioural beliefs and one ANOVA for the control beliefs as manipulation checks to test the differences regarding the addressed beliefs in the experimental conditions. In terms of behavioural beliefs, the results show no significant difference between the groups: $F(3, 549) = 0.55$, $p = .650$ (see Table 5 for mean values).

Equally, for the control beliefs, the results show no significant difference between the groups that received a text addressing control beliefs and those groups that received a text that did not address control beliefs: $F(3, 549) = 0.18$, $p = .907$ (see Table 6 for mean values).

Regarding H1a, the results of the MANCOVA show that the attitude towards the prevention of child poisoning accidents was not significantly higher when behavioural beliefs were addressed in the stimulus compared to when behavioural beliefs were not addressed: $F(1, 528) = 0.03$, $p = .870$, $\eta^2_p < .001$ (see Table 7). Likewise, in terms of H1b, the results of the MANCOVA show that the PBC was not significantly higher when control beliefs were addressed in the stimulus compared to when control beliefs were not addressed: $F(1, 528) = 0.14$, $p = .704$, $\eta^2_p < .001$. For that reason, H1a and H1b have to be rejected (see Table 7).

For H2a, our results show that the intention to adopt preventive behaviour was not significantly higher when behavioural beliefs were addressed in the stimulus compared to when behavioural beliefs were not addressed: $F(1, 528) = 0.70$, $p = .405$, $\eta^2_p = .001$. Furthermore, regarding H2b, the results show that the intention to adopt preventive behaviour was not significantly higher when control beliefs were addressed in the stimulus compared to when

control beliefs were not addressed: $F(1, 528) = 0.90$, $p = .348$, $\eta^2_p = .002$. For that reason, H2a and H2b must also be rejected (see Table 7).

Table 5. Descriptive Analysis of Behavioural Beliefs Between the Experimental Groups

	N	*M*	*SD*
Control Group	133	4.0	0.7
Group Behavioural Beliefs	142	4.1	0.7
Group Control Beliefs	141	4.0	0.7
Combined Group	134	4.1	0.7
Overall	550	4.1	0.7

Note. Results of ANOVA to test differences regarding behavioural beliefs in the experimental conditions: $F(3, 549) = 0.55$, $p = .650$.

Table 6. Descriptive Analysis of Control Beliefs Between the Experimental Groups

	N	*M*	*SD*
Control Group	133	3.9	0.7
Group Behavioural Beliefs	142	3.9	0.8
Group Control Beliefs	141	3.9	0.8
Combined Group	134	3.9	0.8
Overall	550	3.9	0.8

Note. Results of ANOVA to test differences regarding control beliefs in the experimental conditions: $F(3, 549) = 0.18$, $p = .907$.

Table 7. MANCOVA on the Effect of Behavioural Beliefs (BB) and Control Beliefs (CB) on Attitude, Perceived Behavioural Control (PBC), and Intention to Adopt Preventive Behaviour

	Dependent Variables						
	Attitude		PBC		Intention to Adopt Preventive Behaviour		
	F	η^2p	*F*	η^2p	*F*	η^2p	*Wilk's* Λ
Factor							
BB	0.03	< .001	0.10	< .001	0.69	.001	.001
CB	0.53	.001	0.14	< .001	0.88	.002	.006
BB*CB	0.68	.001	<0.01	< .001	0.02	< .001	.002
Control variables							
Risk Perception	1.38	.003	0.18	< .001	12.64***	.023	.964
Affective Reactions	14.56***	.027	6.41*	.012	12.70***	.023	.967
Sex	0.64	.001	0.14	< .001	0.52	.001	.996
Education	3.17	.006	0.01	< .001	1.74	.003	.991
Age	2.87	.005	<0.01	< .001	1.81	.003	.991
Experience Child Accidents	0.19	< .001	0.07	< .001	2.19	.004	.995
Accident Experience	0.16	< .001	0.29	.001	1.66	.003	.994
Age Children	2.50	.005	4.38*	.008	0.20	< .001	.989

*$p < 0.5$. **$p < .01$. ***$p < .001$.

As there was no significant main effect for both the behavioural beliefs (H2a) and the control beliefs (H2b), there was also no interaction effect between the two experimental factors (H2c): $F(1, 528) = 0.02$, $p = .900$, $\eta^2_p < .001$. Therefore, we must also reject H2c in the context of this study (see Table 7).

As the analysis of the manipulation checks (ANOVAs) and the MANCOVA indicated that the manipulation through our stimuli did not work as intended, the mediation analyses to test H3a and H3b were conducted using the beliefs measured in the questionnaire rather than the beliefs manipulated by the stimulus materials. In our mediation model (H3a), a partial mediation of the association between the behavioural beliefs and the behavioural intention could be shown: indirect effect $ab = 0.22$, 95% CI [0.16, 0.28]. Unlike in the MANCOVA (with the experimental factors/manipulated belief content), a total effect of the measured behavioural beliefs on the behavioural intention in our mediation model was noted: $c = 0.44$, $p < .001$. After entering the attitude towards the prevention behaviour into the model, a significant relationship of the mediator by behavioural beliefs was also observed: $a = 0.51$, $p < .001$. Furthermore, the attitude was found to be significantly related to the intention to adopt preventive behaviour in our mediation model: $b = 0.44$, $p < .001$. Accordingly, there was a direct effect after the mediator was entered into the model: $c' = 0.22$, $p < .001$, indicating that the relationship of behavioural beliefs with the behavioural intention is partially mediated by the attitude towards the preventive behaviour. Based on these results, H3a could be confirmed in the context of this study (see Figure 3). In terms of content, this result indicates that individuals perceiving many potential positive consequences of the behaviour have a more positive attitude towards the prevention behaviour, and thus, a higher intention to adopt preventive behaviour.

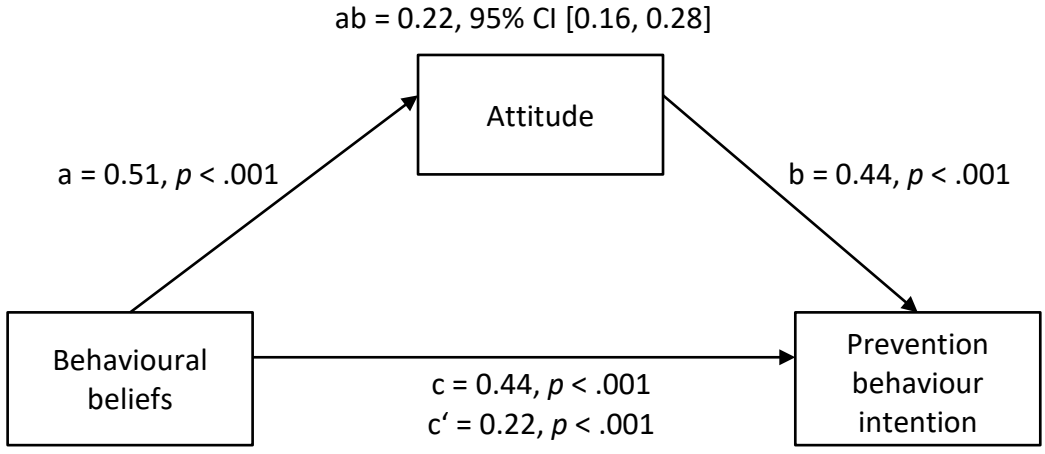

Figure 3. Mediation Model on Attitude

Note. N = 550.

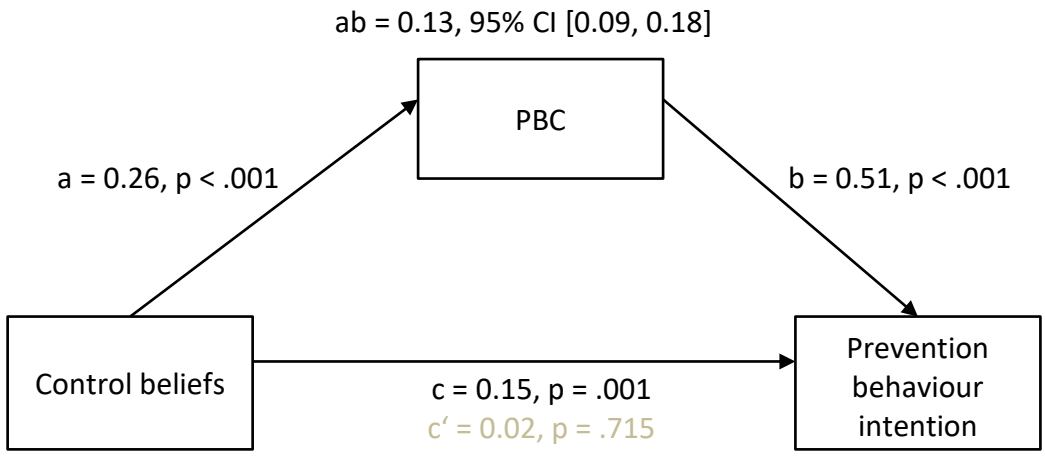

Figure 4. Mediation Model on Perceived Behavioural Control (PBC)
Note. N = 550.

In our second mediation model (H3b), a mediation effect of PBC on the association between control beliefs and the intention to adopt preventive behaviour could be shown: indirect effect *ab* = 0.13, 95% CI [0.09, 0.18]. In contrast to the results from the MANCOVA regarding H2b, in which we used the beliefs manipulated by the stimulus materials, the mediation model in which we used the beliefs measured in the questionnaire shows a total effect of control beliefs on the intention to adopt preventive behaviour: $c = 0.15$, $p = .001$. After PBC was entered into the model as a mediator, there was a significant relationship of the mediator by control beliefs: $a = 0.26$, $p < .001$. Furthermore, the mediator was significantly related to the intention to adopt preventive behaviour: $b = 0.51$, $p < .001$. After PBC was entered into the model as a mediator, there was no longer a direct effect of control beliefs on the behavioural intention: $c' = 0.02$, $p = .715$, indicating that the relationship of control beliefs with the behavioural intention is fully mediated by the PBC. Accordingly, H3b could be confirmed (see Figure 4).

Table 8. Descriptive Analysis of the Dependent Variables

Dependent Variables	Experimental Groups	*M*	*SD*
Intention to Adopt Preventive Behaviour	Control Group	4.1	0.1
	Group Control Beliefs	4.2	0.1
	Group Behavioural Beliefs	4.2	0.1
	Combined Group	4.2	0.1
Attitudes	Control Group	4.4	0.1
	Group Control Beliefs	4.4	0.1
	Group Behavioural Beliefs	4.5	0.1
	Combined Group	4.4	0.1
Perceived Behavioural Control (PBC)	Control Group	4.6	0.1
	Group Control Beliefs	4.6	0.1
	Group Behavioural Beliefs	4.6	0.1
	Combined Group	4.6	0.1

Note. Measurement of intention to adopt preventive behaviour, attitudes, and PBC, each on a 5-point Likert scale (intention to adopt preventive behaviour: 1 = *does not apply at all*, 5 = *fully applies*; attitudes: semantic differential 1 = *negative attitudes*, 5 = *positive attitudes*; PBC: 1 = *not agree at all*, 5 = *totally agree*).

Discussion

As we will discuss below, both the manipulation checks (ANOVAs) and the results of the MANCOVA indicate that the manipulation of the beliefs did not work as expected. However, the mediation analyses based on the measured beliefs support the results found in Study 1. The attitude towards the prevention of child poisoning accidents and the PBC were found to be significantly related to the intention to adopt preventive behaviour, which supports findings from previous research (Chung-Park, 2012). Furthermore, the results indicate that, as postulated in the TPB (Ajzen, 1991), there are relationships between the beliefs, the attitude, the PBC, and the intention to adopt preventive behaviour. However, the results of the ANOVAs show that there are no significant differences between the experimental groups in terms of the behavioural and the control beliefs. This could indicate that our manipulation did not work as well as planned, even though the stimulus materials were designed based on the empirical results of Study 1. If so, that explains that addressing both behavioural beliefs and control beliefs did not have a significant effect on the dependent variables in our MANCOVA. Different possible explanations for why the manipulation could have failed can be suggested: The mean values of the experimental groups show that the intention to adopt preventive behaviour was relatively high in all four groups (see Table 8) as also shown in Study 1. That indicates that a ceiling effect regarding the intention to adopt preventive behaviour may have occurred. Furthermore, as in Study 1, the mean values of susceptibility were relatively low compared to the mean values of severity. These results might also be related to our sample: It seems that our target group is already well-involved in and informed on the topic of child poisoning accidents. Participants may already have implemented some of the preventive measures that we addressed in our study. Thus, in future research, it may be useful to also measure past behaviour and include it in the analyses, as it can be an important factor influencing current or future behaviour or behavioural intention. Furthermore, perhaps the single presentation of our stimulus materials was not sufficient to convey new information to our highly involved target group.

Furthermore, another possible explanation for the fact that our stimulus materials did not lead to the desired effects must be discussed. Our results might also indicate that the procedure of first deriving relevant determinants theoretically and then empirically testing their relationship to the target variable before addressing the identified determinants in campaign messages was not as effective as previously assumed. A meta-analysis on the effectiveness of mass-mediated health campaigns shows that the campaign outcomes did not improve in studies reporting a theory-driven campaign compared to studies without a theoretical basis (Anker et al., 2016). Considering these findings, the assumptions concerning our stimulus materials provide another hint that thought should be given to how exactly theory- and evidence-based messages should be implemented in campaigns to be effective. It seems that it is not sufficient to simply know what content is effective in campaign messages. Instead, it seems that it requires a good amount of preliminary research to identify exactly how campaign messages must be addressed. Moreover, design elements other than message content should also be considered in further research. After having individually discussed the results and limitations of each study, we provide an overall discussion of the findings and limitations of both studies in the following.

Overall Discussion

Our studies offer insights into theory-based determinants of the intention to prevent child injuries, in our case, poisoning accidents. The TPB assumes that the attitude towards a behaviour, the PBC, and the subjective norm are related to the behavioural intention. In both our studies, the attitude towards the prevention of child poisoning accidents and the PBC were significantly related to the intention to adopt preventive behaviour, while the subjective norm was unrelated when tested in Study 1. Moreover, risk perception (at least severity) was related to the intention to adopt preventive behaviour and should therefore be considered as a determinant of the intention to adopt preventive behaviour. Since risk perception is not necessarily part of the behavioural beliefs, and thus not necessarily included in the TPB, these results reveal a theoretical value of our study: Integrating risk perception in theoretical models based on the TPB seems promising to predict the intention to adopt preventive behaviour.

The results of this project must be interpreted against the background of its strengths and limitations. We combined determinants from different theories and models on a theoretical basis to create a new model to explain the intention to adopt preventive behaviour. To test the effect of theoretically based and empirically identified message strategies, we linked survey data with experimental data. One limitation of our two studies is that our results are based on cross-sectional data that only measured behavioural intention and not actual behaviour. As known from other contexts, it can be assumed that a gap between the behavioural intention and actual behaviour, the so-called intention-behaviour-gap, exists (Sheeran & Webb, 2016). Accordingly, based on our research, it is impossible to provide any predictions about actual behaviour in the context of preventing child poisoning accidents. Furthermore, the operationalisation of the beliefs in Study 1 using inverted items should be discussed. The results of the regression analysis in Study 1 show that most of the inverted items were not significant. A possible explanation for these results is that due to insufficient attention, the participants might not have noticed the inverted wording of the items. In further studies, the questionnaire should be designed with a great deal of variety to ensure the continuous attention of the participants during participation. In this regard, variety should be accomplished in a different manner than using inverted items, as our study indicates that they are not suitable for increasing participants' attention but rather tend to result in distorted responses. Furthermore, clear wording should be used to minimise the risk of misunderstandings. Moreover, in Study 2, we did not measure the intention to adopt preventive behaviour before the exposition to our stimulus, and we did not include a control group that did not receive any text. Accordingly, there is the possibility that the text containing the general information on child poisoning accidents already had an effect on the intention to adopt preventive behaviour that we could not control. Nevertheless, our studies offer a theoretically and empirically based insight into the determinants of behavioural intention to prevent child poisoning accidents.

Based on our results, there are opportunities for further research: As we used the prevention of child poisoning accidents as a use case and derived the determinants of our model from well-established models and theories that are not explicitly related to child poisoning accidents, our model could be transferred to other domains of (child accident) prevention. Moreover, further determinants could be added to the model to increase its explanatory power. As the manipulation checks (ANOVAs) and the MANCOVA in our study 2 indicate that the manipulation through our stimuli did not work as intended, the effects of the mediation analyses are based on the beliefs measured in the questionnaire instead of the experimental factors.

Therefore, it would be interesting to replicate our Study 2 and use different stimulus materials or a higher exposure frequency and duration to intensify their efficacy. As mentioned, our results are based solely on cross-sectional data. Accordingly, there is a need to investigate determinants of preventive behaviour and message content to address these in a longitudinal design.

The results of our study provide further evidence that identifying message content theory- and evidence-based alone may not be sufficient to increase campaign effectiveness. Instead, it seems that in further research, it takes a lot of preliminary research to obtain insight into the effective design of other factors that might influence the effectiveness of campaign messages.

Conclusion

The results of our project allow for valuable insights into the determinants of parents' intention to implement poisoning prevention measures. Both studies showed positive relationships of the attitude towards preventive behaviour and PBC with the intention to adopt preventive behaviour. The theory- and evidence-based model we provide is based on well-established models and may be transferable to other injury prevention topics and health domains. However, further potential determinants should be explored to increase its explanatory power.

Although not all hypotheses could be supported, the implemented models/theories, previous research, and the results from our studies offer a good case to assume that addressing the attitude towards preventive behaviour, the PBC, and risk perception may be useful in the communication of child accident prevention

Ethical Approval

Ethical approval for survey data used in this manuscript has been granted by the advisory board on ethical issues of the University of Erfurt (No. 20210715).

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Conflict of Interest

We confirm that no known conflicts of interest exist for this publication. There has been no financial support that could have influenced the outcome.

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