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Johann Caro-Burnett

NERPS

Hiroshima University

Aina Kajisawa

Graduate School for International Development and Cooperation (IDEC)

Hiroshima University

Shinji Kaneko

NERPS

Hiroshima University

Department of Development Policy

Division of Development Science

Graduate School for International

Development and Cooperation (IDEC)

Hiroshima University

1-5-1 Kagamiyama, Higashi-hiroshima

7398529 Japan

Reverse Inter-Generational Information Transmission: A Study of Hand Sanitizer Gel in Cambodia*

Johann Caro-Burnett† Aina Kajisawa Shinji Kaneko‡

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Abstract

We conduct a field experiment to study information transmission from children to their parents. We aim to promote the usage of an alcohol-based hand sanitizer, by teaching children its benefits and then test whether (*i*) information has been transmitted and (*ii*) information has an impact on the decision to purchase the hand gel. Moreover, in addition to a lecture on the benefits of the hand gel, our intervention implements a hands-on experience where children actually use the hand gel. We show that the average treatment effect of our intervention is positive on parents' information, thus information is transmitted. Moreover, we use an instrumental variable approach to show that higher information implies a higher probability to purchase more hand gel.

Keywords: Sanitation; Alcohol-based sanitizer; Hand-washing; RCT

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†Hiroshima University and NERPS. johanncb@hiroshima-u.ac.jp.

‡Hiroshima University and NERPS. kshinji@hiroshima-u.ac.jp.

1 Introduction

Inter-generational information transmission is a typical way to share knowledge, skills, and values from parents to their children (Kuczynski and Parkin, 2007). Moreover, although less common, it is also true that children can share knowledge with and influence their parents (Ambert, 2001; Kuczynski and Parkin, 2007; Knafo and Galansky, 2008; Istead and Shapiro, 2014; Boström and Schmidt-Hertha, 2017). We will refer to this mechanism of information transmission from children to parents as *reverse inter-generational* transmission (RIGT). RIGT has been studied in the context of waste segregation (Maddox et al., 2011) , education about wetlands (Damerell et al., 2013; Rakotomamonjy et al., 2015), energy saving (Boudet et al., 2016), traffic (Ben-Bassat and Avnieli, 2016), medical checkups (Celis et al., 2017), climate change (Lawson et al., 2019; Parth et al., 2020), and Sanitation (O'reilly et al., 2008; Lewis et al., 2018).

So far, the literature has mainly focused on the RIGT of (pure) information acquired by children. In this study, we add a hands-on experience, so that children can better transmit information to their parents. In addition, we want to test whether this possibly new information is persuasive enough to influence parents' decision-making.

To measure the effects of Knowledge (K) and Knowledge + Experience (K+E), we conduct a randomized controlled trial (RCT) in Phnom Penh, Cambodia. Our subjects are students from 7th to 9th grade at *Trapeang Sala Secondary School*.[1] The intervention consisted on either (pure) information about the benefits of using an alcohol-based hand sanitizer or the same information plus an additional session of a real life experience using the hand gel.

According to the Center for Disease Control (CDC), the act of keeping our hands clean is one

[1]There is evidence suggesting that teenagers, rather than young children, are more likely to influence their parents (Vollebergh et al., 2001).

of the most important steps we can take to avoid getting and spreading diseases.[2] This statement became especially relevant after the 2020 COVID-19 pandemic. Both the World Health Organization (WHO) and the CDC recommend using a hand sanitizer with more than 60% alcohol. Moreover, the gel version of a hand sanitizer is more effective than regular soap (and particularly important for controlling enveloped disease, such as COVID-19 Nuwagaba et al., 2020), and it is a dominant substitute in areas where clean water is highly valuable.[3]

In our intervention, we measured two outcomes: parents level of information about hand gel and their decision to purchase it. The level of information is measured using two explicit points about the hand gel we made during the lecture. Using a standard average treatment effect (ATE) approach, we show that parents of children in groups K and K+E are 20% and 25% more likely to respond both questions correctly, respectively.

To study the decision to purchase as a function of the available information, we take several considerations into account. First, conditional on a certain level of information, our treatment should have no predictive power. Second, we do not have reliable relevant covariates (only self-reported) such as education, income, etc. Thus, any estimation of the effect of information on the decision to purchase would be biased. To solve this issue, we use an instrumental variables approach. The natural candidates to be used as instruments are our intervention groups, since they are exogenous and have a predictive power on the parents' available information. Moreover, since we the purchased units and our measure of information are discrete, instead of the usual two-stage least squares (2SLS), we use a two-stage ordered probit-ordered probit.

The rest of this paper is structured as follows: in section 2, we describe our intervention in detail

[2] CDC (2020)
[3] Luby et al. (2010); Pickering et al. (2013).

and we briefly describe the process of our data collection. In section 3 we show our results. Finally, we conclude in section 4.

2 Experiment Design and Data Collection

We conducted an RCT in the rural area of Phnom Penh, Cambodia, from November 16, 2019 to November 27, 2019. Our subjects are students (and their parents) from 7th to 9th grade at *Trapeang Sala Secondary School*. In those three classes, there were 551 registered students. Because we are interested in the RIGT of information, in cases of multiple registered siblings, we only kept the oldest one. In addition, some students were absent from the intervention; thus, we randomized our treatments over 387 students.

We randomly assigned the students to one of three groups. The first group (Knowledge group, n=132) was given a brief lecture on infectious diseases that are usually transmitted by hand, as well as four benefits of using hand sanitizer, described on table 1. The second group (Knowledge + Experience group, n=123) attended an identical lecture, and in addition, was given the opportunity to actually use the hand gel.[4] Finally, the third one (Control group, n=132) did not receive any treatment.

Table 1: Information Provided to Children

1. Alcohol-based sanitizer can effectively kill germs
2. It is easy to carry
3. It does not require water, and it is a substitute for soap
4. The gel dries in 20 seconds, and thus, there is no need for towel

All groups were instructed on how to purchase up to five discounted 50 ml hand sanitizer bottles

[4]According to our baseline survey, some households already had experience using the hand gel.

from us.[5] The procedure was to give their parents a form to be filled specifying how many bottles they want to buy, and then bring back, the next day, the form with the payment. The information lecture lasted about 10 minutes, the hand-washing experience lasted about 5 minutes, and the explanation about how to purchase the discounted hand sanitizer lasted less than five minutes. The attendees were given the order form and asked to go back home as soon as the intervention was over.

The next morning, students submitted the filled forms and cash to purchase the hand sanitizer. From the 387 students, 72 did not bring back their purchase form. We provided a questionnaire to be filled by the parents of the students, asking them demographic information and a quiz on basic hygiene including two of the benefits of hand gel from table 1 (which are the variables we care about). Students were told that if the additional questionnaire was filled and returned, they would receive school supplies as an incentive. This questionnaire was meant to be filled only by those who submitted the purchase form (including zero purchased units). However, some students who did not submit the purchase form accidentally received the questionnaire as well, this is not a problem as we can always exclude their data.

From the 387 students, 61 students do not have data about the information transmitted to parents, either because they did not bring back their purchase form or because their parents' questionnaire was missing those questions. Thus we have information transmission data from 326 parents. Moreover, if from those 326, we also exclude the ones who did not submit their purchase form (but accidentally received the quiz), we end up with 301 observations. In addition, independently of the previously mentioned issues, out of the 387 students, 71 participated on a late intervention due to conflicting schedules. However, since the conflicting schedules is exogenous, and there was no communication between students, this does not affect our results. On the other hand, we strongly believe that the

[5] We offered a 50% discount, and the final price was approximately 0.5 USD.

event of not bringing back to school the purchase form may have been intentional in many cases. We control for all these potential issues in section 3.

To measure the ATE of our intervention on the information acquired by parents, we use either a linear regression or a probit model. The linear model to explain the information that parent of child i has is:

$$Information_i = \beta_0 + \beta_1 group(K)_i + \beta_2 group(K+E)_i + \epsilon \quad (1)$$

where $Information_i$ is either (i) the number of correct quiz answers $(Y1 = 0, 1, 2)$, or (ii) a dummy variable indicating whether both quiz answers were correct $(Y2 = 0, 1)$, $group(K)_i$ is a dummy variable that equals one if child i belongs to the treatment group K and zero other wise. Similarly, $group(K+E)_i$ is a dummy variable that equals one if child i belongs to the treatment group $K+E$ and zero otherwise.

In addition, since our outcome variable is discrete, we use a probit model to explain RIGT as a function of our intervention. Let Y_i^* be an unobservable variable that measures the whole information available to parents, and equals:

$$Y_i^* = \beta_0 + \beta_1 group(K)_i + \beta_2 group(K+E)_i + \epsilon$$

where ϵ is $N(0,1)$ and the β parameters are not necessarily the same as the ones in equation (1). Instead of Y_i^*, we observe the quiz answer outcomes that depend on the information as follows:

$$Y2_i = \begin{cases} 1 & \text{if } Y_i^* \geq \text{Cut}^I \\ 0 & \text{if } Y_i^* < \text{Cut}^I \end{cases} \tag{2}$$

where Cut^I is a threshold of information quality. Then, the probit model estimates the *beta* parameters as well as the threshold.

Finally, the decision to purchase bottles of hand gel is also a discrete variable. Because of that, we would like to model it using an ordered probit similar to equation (2), but since the choice set is $\{0, 1, 2, 3, 4, 5\}$, we need five threshold to be estimated. Thus, let's say that there is an unobservable variable Q_i^* that measures the "level of happiness" of a parent from buying hand gel as a function of, among other determinants, the parent's available information $Y2$:

$$Q_i^* = \gamma_0 + \gamma_1 Y2_i + \nu$$

Note that conditional on acquired information $Y2$, our treatments do not have any predictive power. That is the reason they are omitted from the previous equation. Then, the actual purchased units Q_i are given by the following rule:

$$Q_i = \begin{cases} 5 & \text{if } Q_i^* \geq \text{Cut\_5} \\ 4 & \text{if Cut\_5} > Q_i^* \geq \text{Cut\_4} \\ 3 & \text{if Cut\_4} > Q_i^* \geq \text{Cut\_3} \\ 2 & \text{if Cut\_3} > Q_i^* \geq \text{Cut\_2} \\ 1 & \text{if Cut\_2} > Q_i^* \geq \text{Cut\_1} \\ 0 & \text{if } Q_i^* < \text{Cut\_1} \end{cases} \tag{3}$$

Moreover, we note that in equations (1) and (2), the error term ϵ is independent from the treatment groups, as they are randomly assigned. On the other hand, the error term ν in equation (3) is not necessarily independent from the information measure $Y2$. The reason is that there are unobservable covariates that have predictive power over the decision to purchase and are also potentially correlated to the amount of information, such as education and income. Thus a simple probit approach could yield biased estimations of the *gamma* parameters.

In order to solve this issue, we use an instrumental variable approach. Instead of the usual 2SLS, we use a two-stage double ordered probit. That is, since our treatment groups are exogenous, we use equation (2) as a first stage to predict an exogenous version of the information measure $Y2$ to be used as an explanatory variable in equation (3).[6]

[6] Note that we miss information by using $Y2$ istead of Y^*, which is not observed. The command *cmp* in Stata takes this into account when calculating the standard errors.

3 Results

We measure the effect of RIGT of information on two outcomes: whether information was transmitted and whether this (newly acquired) information can influence parents' decision to purchase hand gel. Moreover, for the information transmission, we want to distinguish whether the children attended only the lecture session or they additionally experienced the hand gel.

3.1 Information Transmission

The first question we answer is whether parents actually learned from the information transmitted by their children. To measure this RIGT, we provided an additional quiz to the parents of the children, where we asked two specific question from the information we explicitly provided to their children. Namely, we asked about points 3 and 4 from table 1:

Q1. The gel hand sanitizer is a substitute for soap and does not require water. Answer *true* or *false*.

Q2. The gel hand sanitizer does not require a towel because it dries in:

a) 5 seconds

b) 10 seconds

c) 15 seconds

d) 20 seconds

In addition, we asked other general hygiene questions to disguise the ones coming directly from our intervention. We evaluate RIGT using our information measures $Y1$ and $Y2$. In addition, we have two treatments: $K =$ (pure) knowledge and $K + E =$ knowledge plus experience. The ATE of our intervention are shown in table 2.

Table 2: RIGT

VARIABLES	(1)	(2)	(3)	(4)	(5)
K	0.216***	0.195***	0.195***	0.193***	0.718***
	(0.0632)	(0.0513)	(0.0515)	(0.0541)	(0.214)
K+E	0.288***	0.247***	0.248***	0.259***	1.205***
	(0.0545)	(0.0465)	(0.0463)	(0.0481)	(0.261)
Late Intervention			-0.0174		
			(0.0529)		
Constant	1.664***	0.705***	0.708***	0.699***	
	(0.0502)	(0.0415)	(0.0431)	(0.0434)	
Cut^I					-0.522***
					(0.124)
Observations	326	326	326	301	301

Columns (1) to (4) are linear regressions. Column (5) is an probit. The outcome variable in column (1) is $Y1$, the number of correctly answered questions regarding points 3 and 4 from table 1. Columns (2) and (5) measure $Y2$, a dummy indicating whether both questions were correct. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Huber-White robust errors are displayed in parenthesis.

Column (1) in table 2 shows the effect of the treatments on the number of correct questions that parents answered ($Y1$), while columns (2) and (5) show the effect of the treatments on whether parents answered both questions correctly ($Y2$). Moreover, columns (1) to (4) are linear regressions (equation 1), while column (5) is an probit regression (equation 2). In columns (4) and (5), we omitted the students who did not hand in their purchasing form. The constant terms show that parents of children in the control group got on average 1.664 (out of 2) correct questions; and about 70% of parents in the control group got both answers correct. In addition, column (2) shows that about 90% (70.5% + 19.5%) of the parents of children in the pure knowledge group got both answers correct. Similarly, about 95.2% (70.5% + 24.7%) of the parents of children in the knowledge plus experience group got both answers correct. That means children in treatment groups K and $K+E$ transmitted information to their parents. In column (3), we see that participating on a late intervention does not affect the results.

Similarly, from equations (4) and (5), we see that students who (either purposely or accidentally) forgot their purchasing forms do not change the information transmission. To interpret column (5), we need to calculate the marginal effects from the probit model, which because of the simplicity of the data are identical to the linear regression marginal effects, as shown in table 3.

Table 3: Marginal Effects from Ordered Probit

	$P(Y2 = 0 \mid Treatment)$	$P(Y2 = 1 \mid Treatment)$
Control	29.5%	70.5%
K	10.0%	90.0%
K+E	4.8%	95.2%

Distribution of acquired information. The first row corresponds to the control group, the second row corresponds to the knowledge group, and the third row corresponds to the knowledge plus experience group.

3.2 Information and Decision-Making

In the previous section, we established that information was effectively being shared through RIGT. The second question we want to answer is whether this new information is persuasive enough to influence the parents of the subjects. Parents were allowed to purchase up to five bottles of gel at a discounted price. Because the purchase options are a discrete variable, we also focus on a discrete choice model, which is an ordered probit. More importantly, we want to model purchase as a function of information; however, some parents may have already had information about the benefits of using hand sanitizer.[7] This is not necessarily a problem per se; however, it is a problem if this information is correlated with some unobservable variable that affects the decision to purchase (i.e. education, income, etc).

We can fix this issue using an instrumental variable, and luckily we have the perfect instrument for

[7] As even 70% the control group got both questions correct.

Table 4: Influencing the Purchase Decision

VARIABLES	(1)	(2)	(3)
Y2	0.134	0.890**	0.864**
	(0.164)	(0.379)	(0.386)
K	0.231		
	(0.145)		
K+E	0.0834		
	(0.146)		
Form		6.849***	
		(0.300)	
Cut 1	-1.088***	5.793***	-1.084***
	(0.162)	(0.149)	(0.399)
Cut 2	0.0704	7.408***	0.534
	(0.152)	(0.0846)	(0.338)
Cut 3	0.770***	8.138***	1.266***
	(0.156)	(0.0637)	(0.327)
Cut 4	1.093***	8.465***	1.594***
	(0.161)	(0.0485)	(0.326)
Cut 5	1.319***	8.690***	1.820***
	(0.166)	(0.0467)	(0.327)
K		0.802***	0.780***
		(0.200)	(0.205)
K+E		1.122***	1.200***
		(0.239)	(0.259)
Cut^I		-0.525***	-0.507***
		(0.117)	(0.121)
Observations	326	326	301

Column (1) is an ordered probit model, and columns (2) and (3) are two-stage ordered probit - ordered probit regressions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Huber-White robust errors are displayed in parenthesis.

that: our treatment groups, which are exogenous, and affect the information parents have, as shown in the previous section. Moreover, because both, purchasing and information, are discrete variables, instead of the usual 2SLS approach, we use a two-stage ordered probit-ordered probit. Finally, we observed that 72 children did not bring their purchase form the day after the intervention. We suspect that many of them did it purposely (i.e. to avoid embarrassment from classmates for not being able to purchase any units). To address this issue, we code their purchase as zero, and we take two parallel approaches: (*i*) we add a dummy variable (*Form*) indicating which of those students brought their purchase form, and (*ii*) we omit students who did not bring their form ($Form = 0$) from the regression. In table 4, we show our estimations using a non-instrumented regression and the instrumented one.

The upper panel of table 4 shows the estimations of the intended model: purchased bottles of gel as a function of information ($Y2$), while the lower panel shows the first stage only in the case of the instrumented regressions. As a benchmark, column (1) would tell us that the information about the advantages of hand gel does not affect the decision to purchase it. However, as we explained, this information is not exogenous. In addition, we confirm that the treatment groups alone have no predictive power over the purchase decision. That is, the intervention should only affect the purchase decision via information transmission. In columns (2) and (3), we show that after correcting for endogeneity, information does have a positive impact on the decision to purchase.

Table 5: Marginal Effects from the Two-Stage Double Probit

	$P(Q\|Information)$					
	Q=0	Q=1	Q=2	Q=3	Q=4	Q=5
Y2=0	14.54%	56.64%	18.95%	4.57%	2.03%	3.28%
Y2=1	2.58%	34.43%	28.48%	11.10%	6.32%	17.08%

Distribution of purchased units, according to column (2) in table 4 conditional on returning the purchase form ($Form = 1$).

In table 5, we calculate the marginal effects of the distribution of purchased units as a function of $Y2$, from the coefficients of column (2) in table 4 evaluated at $Form = 1$. We can see that the likelihood of purchasing more units increases with the information measure $Y2$. For instance, the probability of not buying any units is 14.5% for parents who responded at least one of the quiz questions wrong, and 2.6% for parents who got both questions correct. Conversely, the probability to buy five units is 3.3% for parents who got at least one question wrong, and 17.1% for parents who got both questions right.

Finally, we want to calculate the overall probability of purchasing Q units given the received treatment. To do so, we use our assumption which was also confirmed on column (1) of table 4 that conditional on information, the treatments do not have predictive power over the purchased quantity. Formally: $P(Q|Information, Treatment) = P(Q|Information)$. Next, we calculate the probability of purchasing Q units conditional on the treatment as follows:

$$\begin{aligned} P(Q|Treatment) &= \sum_{Y2} P(Q|Y2, Treatment)P(Y2|Treatment) \\ &= \sum_{Y2} P(Q|Treatment)P(Y2|Treatment) \qquad (4) \end{aligned}$$

Based on equation (4), we can use tables 3 and 5 to calculate the desired probabilities, which are displayed in table 6. This table shows the probability to purchase Q units given the treatment group. We can see that both treatment groups, and especially K+E, have a higher probability to purchase more units compared to the control group. For instance, the probability to buy one or less units is 47.09%, 40.43% and 38.65% for treatment groups control, K and K+E, respectively. Similarly the probability to buy four or more units is 18.07%, 21.6% and 22.54% for treatment groups control, K and K+E, respectively.

Table 6: Distribution of the Quantity Conditional on the Treatment

	$P(Q\|Treatment)$					
	Q=0	Q=1	Q=2	Q=3	Q=4	Q=5
Control	6.11%	40.98%	25.67%	9.18%	5.06%	13.01%
K	3.78%	36.65%	27.53%	10.45%	5.89%	15.70%
K+E	3.15%	35.50%	28.03%	10.79%	6.12%	16.42%

Distribution of purchased units, conditional on the treatment, calculated using equation (4), and tables 3 and 5.

4 Conclusions

In this study, we assessed the impact of RIGT of information from school children to their parents, and whether this information affects their decision-making. To do so, we implemented an RCT focused on the benefits of hand hygiene and gel sanitizer to Cambodian school children and their parents. We show that both treatments, knowledge and knowledge plus experience, have a positive effect on the quiz taken by the parents about the benefits of the hand gel. Namely, while the control group was about 70% likely to answer both quiz questions correctly, the pure knowledge group was about 90% likely to do so; and, more importantly, the knowledge plus experience group was about 95% likely.

We also show that the information parents have on the benefits of hand gel affects their decision to purchase this product. As expected, conditional on the information known by parents, the treatments do not have any predictive power. We used an instrumental variable approach to solve the fact that there are unobservable variables that are correlated to information, to estimate the impact that information transmission has on the decision to purchase hand gel. We show that, indeed, better information significantly increases the probability to purchase more units.

In addition, our hands-on treatment has a marginal improvement compared to the purely theoretical treatment in both, information transmission and the decision to purchase hand gel. On the other hand, we believe that on large scales, a few percentage points are measurable, and more so during a pandemic like the one devastating currently the entire world. On the other hand, we believe more experimental evidence on the hands-on treatment is needed. The unexpected outcome that our control group had a 70% change of answering both quiz questions correctly suggests that it would be interesting to conduct RIGT interventions where the information is less basic.

Our intervention, which was conducted in November 2019, had an unanticipated perfect timing because of two reasons. First, due to the COVID-19 pandemic, it would have been impossible to conduct our experiment even a couple of months later. More importantly, also because of the 2020 pandemic, our intervention became especially relevant since we show that with a simple and at almost zero cost intervention on children, we can change real life economic behavior of parents. This is relevant for sanitation and policy implementation in low income countries.

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