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## Measuring Product-Related Stigma in Design

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**Abstract:** Many medical and assistive devices are experienced as unpleasant and uncomfortable. On top of their discomfort, product users may also experience social unease. We label this process “product-related stigma” (PRS).

This paper presents two measuring techniques that aim to objectively assess the ‘degree’ of PRS that is ‘attached’ to products. Both experiments focus on the behavioral deviations in the walking path of passers-by during a public and unprepared encounter with a user of a stigma-sensitive product (dust mask).

The ‘Dyadic Distance Experiment’ measures exact interpersonal distances, whereas the ‘Stain Dilemma Experiment’ presents the passer-by with a choice in his walking path.

Both experimental techniques are predominantly suited as comparison tools, able to compare products on their PRS-eliciting potential.

Designers and developers can use these results to justify design decisions with quantitative data, to assess which product properties have influenced certain reactions, and to what extent subsequent improvements have been successful.

**Keywords:** Product Semantics, Design for health, Design and Emotion, Inclusive Design

### 1. Introduction

Imagine that you are walking through the local shopping mall, wearing a dust mask. Apart from your own discomfort, you might also experience social unease in the people around you. As they approach, you might observe their anxiety, laughs, or frowns. As they pass, you might feel how they keep their distance from you. Reactions elicited by these unprepared encounters are at the basis of the research presented in this paper.

We label this phenomena product-related stigma (PRS). PRS considers stigma-charged interactions and conflicts between products, users, and bystanders within a specific cultural setting (in the example above for example, we refer to the Western culture). Due to the



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process of PRS, a user that was unconstrained by any stigma may engender stigmatic reactions because of the product he or she has to use, regardless of whether this usage is voluntarily or forced.

### *Stigma-sensitive products*

Due to their appearance, and enforced by existing stereotypes, certain products can become burdened with stigma-sensitivity. Some stigma-sensitive products carry a long history of rejection while others become questionable or undesirable as soon as they move out of their intended context or culture. An invisible hearing aid or a prosthetic leg that is covered by clothing will not attract people's attention. As soon as it becomes visible to bystanders, the interaction changes. Hence, visibility is an important factor (Goffman, 1963; see also Jones et al. 1984, for a discussion of six dimensions of stigma). Our insights apply to those products that are visibly worn or used in close proximity to the human body, where they are perceived and evaluated by people in the immediate vicinity.

Products that can be linked to PRS include:

- Protective devices: all products that are intended to free us from discomforting or unsafe situations. (dust masks, hearing protectors, etc.).
- Assistive and medical devices: Products that assist or complement the human body and promote user independence in daily tasks (wheelchairs, crutches and prosthetics). Related, yet overlapping are the medical devices that are used for monitoring, treatment or revalidation.

In future research we would like to assess if our insights can be extended to all products that are semantically linked to the body. In the following decades much more technology-driven products will become a complement to our bodies. These products will not only stretch the boundaries of our capabilities, but they also give rise to new and unfamiliar body-near artifacts that may or may not be socially accepted and approved of (Google glass, Microsoft HoloLens, etc).

In both studies we used dust masks as stimuli. They attract visual attention, are semantically linked to the user, and are stigma-sensitive within our Western culture. We do acknowledge that dust masks have different cultural meaning depending on where they are used. Although often intriguing to the Western eye, protecting the face from polluted air, cold weather, sun or viruses is common behaviour in China and other Asian countries. In those cultures dust masks are an everyday product that serves a broad range of needs ranging from self-protection to health etiquette.

### *Behavioral reactions of bystanders and passers-by*

Once bystanders have perceived and appraised the user and his or her stigma sensitive product, they have several ways in which they can respond and behave. Bystanders often demonstrate mixed appraisals and responses. Although people may feel some revulsion to a user of a prosthetic arm, their actual behavior may reflect sympathy and kindness. In order

to explain such findings, social psychologists have proposed a variety of dual process models (Gawronski and Bodenhausen, 2006; Pryor et al., 1999; Smith & De Coster, 2000; Strack & Deutsch, 2004).

As the basis for our experimental explorations we opted for the dual process model as proposed by Pryor et al. (2004). Pryor indicated that there is an important reflex reaction within the first second, possibly followed by a more deliberate reaction that takes its time to build up.

A thorough assessment of the behavioral reactions of bystanders implies a study of the initial confrontation as well as the more deliberate and thoughtful responses that follow.

We initiated our explorations in Italy with a study of the avoidance-related reflex reactions of bystanders to dust masks. The 'Approach and Avoidance experiment' (Vaes, 2010) was set in a lab environment and captured reflex reactions to pictures of people with and without dust masks, presented on a screen.

During the experimental explorations that followed, we shifted our focus away from the lab and towards the real-life encounter between dust mask users and bystanders. In our attempt to approach and observe the real phenomenon we quantified the PRS-potential of products by studying the behavioral reactions of bystanders during a public and unprepared encounter with users of stigma-eliciting products. This unprepared encounter proved to be a good instance for measuring behavior, because passers-by are unable to 'mask' their reactions in these instances. We gradually progressed towards the parameter of interpersonal distance as a promising measure, more specifically, the moment in which the passer-by passes our product user. By averaging the behavioral reactions of a large sample of random passers-by varying in age, gender and ethnicity, we were able to obtain a more objective measure.

#### *Interpersonal dissociation (social distance) and avoidance*

A defining and immediate reaction to stigma seems to be avoidance. Measuring interpersonal or social distance is a common method used to examine stigma and it refers to people's willingness to avoid versus interact with individuals (LeBel, 2008). Previous explorations clearly indicated that the presence of a stigma-eliciting dust mask affects the interpersonal distance between the passer-by and the research partner. (Vaes, 2012)

Hall (1966) states that the social distance between people is reliably correlated with physical distance, as are intimate and personal distance, according to the following delineations: intimate distance for embracing, touching or whispering (15 to 46 cm), personal distance for interactions among good friends or family members (46 to 120 cm), social distance for interactions among acquaintances (120cm to 370cm), and finally the public distance used for public speaking (370 cm or more) (figure 1).



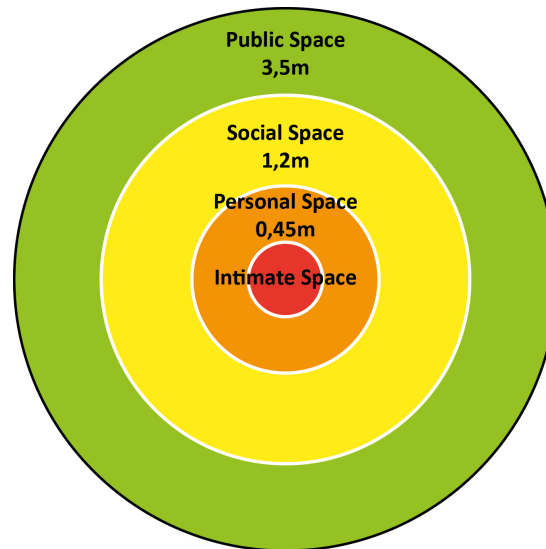


Figure 1. Correlation between social distance and physical distance between people (Hall, 1966).

Hall (1966) also noted that different cultures maintain different standards of personal space. He separated cultures into two basic categories: contact and non-contact. In contact cultures, physical touching between acquaintances is permitted and even necessary for establishing interpersonal relationships. Such cultures include Arab, Italian, French, Latin America, and Turkish. For non-contact cultures, touching is reserved for only the most intimate acquaintances. Examples include the U.S., Norway, Japan, and most Southeast Asian cultures. As such the cultural setting will influence the results of the experiments that follow.

## 2. The Dyadic Distance experiment

### 2.1 Experimental stimuli, setup and participants

The location and stimuli are kept identical for both experiments. By simulating real-life conditions, both experiments measure the valuable ‘first encounter’ of a large group of passers-by, in a natural setting, with a research partner that wears one of five distinct dust mask typologies.

In both experiments the independent variables are the gender of the research partner (mask wearer) and the mask/no-mask conditions. All variables are manipulated between participants. We now discuss the stimuli, experimental setup and participants, which are the same for both experiments. After this overview we present each experimental technique separately.

#### *Stimuli*

Both experiments are repeated for five distinct mask types and a no-mask reference situation, as presented in figure 2. During the course of the experiments, we briefly incorporated a green respiratory mask (not depicted). This mask proved to be out of context

for this experiment. Because the mask conditions did not interfere with each other during the actual experiments, we chose to exclude this condition from the experimental sample.



No-mask: reference condition  
(Referred to as 'no-mask')

White disposable dust mask:  
Headband behind the ears, no  
breathing valves. (Referred to  
as 'white mask')

Red Respro City mask:  
Neoprene cycling mask with  
breathing valves on both sides.  
(Referred to as 'respro mask')



Respro Bandit Scarf: Filter  
laminated between cotton  
materials of scarf. Printed  
pattern in dark grey and black.  
(Referred to as 'scarf mask')

Mask prototype 1: Transparent  
mask, mouth and nose are  
visible. Fine orange edge.  
(Referred to as 'prototype  
transparent')

Mask prototype 2: Transparent  
front with sporty looks and  
details. (Referred to as  
'prototype sport')

Figure 2. The mask stimuli: five mask types and a no-mask reference situation

### Experimental setup

In our attempt to simulate a real-life encounter, we took both experiments outdoors and selected a suitable city location. The location was selected in such a way that passers-by would experience as little visual and physical distraction as possible (i.e. physical obstructions, visually competing signals, or competing pedestrian circulation). Both experiments were set on a wide sidewalk close to the central railway station of Antwerp, Belgium. Pedestrian traffic on this 320 cm wide sidewalk is mostly one-directional and unhindered over a length of at least 10 m. The street had limited car traffic and potential effects of social insecurity were not present. Our research partner took a position next to the staircase of a metro exit. The 120 cm high wall of the metro exit provided a suitable surface

for positioning the measuring device of the Dyadic Distance experiment. Measurements were done in one direction only.

These are the requirements that were observed while selecting the proper location:

- No object within a range of 500 cm of the research partner.
- No bad or extreme weather conditions while performing the experiments. Weather conditions were equal in both experiments and for the various mask conditions.
- We performed the experiments between 3 p.m. and 6 p.m. in the afternoon. At that time, pedestrian traffic proved to be constant on that specific sidewalk, resulting in a flow of approximately three passers-by per minute.

The research partner was dressed discretely and acted unsuspecting. These are the requirements that were accounted for in the selection and preparation of the research partner:

- No eye-catching or too colorful clothing
- No visual referral to subcultures or social groups
- Normal build: average in size, weight and attractiveness
- No extra accessories or visual attributes such as headphones, hats, bags, rucksacks, jewelry, piercings, tattoos, etc.
- No potentially stigmatizing physical conditions: physical abnormalities, smell, noises, etc.

In both experiments, the research partner oriented him or herself towards the approaching passer-by.

### *Participants*

Due to the vicinity of the central railway station, this location presented us with a broad spectrum of participants, ranging in age, gender, and nationality.

The research was conducted on a sample of 392 passers-by for the Dyadic distance experiment and a sample of 480 passers-by for the Stain Dilemma experiment. All participants participated unknowingly and were unaware of the experimental setup or its intentions. Because the video images were used only as a visual backup, participants were not informed about the intentions of our research, nor did we ask permission to process the images. Male and female participants and partners were counterbalanced within each condition (no-mask, and the five mask conditions).

To qualify as a valid participant, passers-by had to conform to these specifications:

- People behave different if they are in a group. Due to these behavioral differences, only singular passers-by were included in the sample. Passers-by

had to maintain an interpersonal distance greater than 150 cm in order to qualify as a singular individual.

- Passers-by walking in the reverse direction were excluded from the sample.
- Passers-by accompanied by an animal were excluded from the sample.
- Passers-by who were obstructed during the interaction were excluded from the sample
- Passers-by who encountered or were engaged in distracting activities such as listening to sirens, phone conversation, listening to music, or lighting a cigarette, were excluded from the sample.

## 2.2 Method

The dependent variable that was measured in this experiment is called the dyadic distance. By definition, a “dyad” is a collection of two people, the smallest possible social unit. As an adjective, “dyadic” describes their interaction. In this study we use the term “Dyadic Distance” to describe the shortest interpersonal distance between the two people of interest, the passer-by and our research partner (labeled as DD in figure 3).

The experiment registered the behavior of people passing by a partner wearing a dust mask in a discrete setup. During the course of the experiment the research partner was discretely occupied and did not make visual eye contact with any passers-by. The walking and staring behavior of the passers-by was registered by 2 HD cameras and provided us with rich user insights on the interaction. No further analysis was performed on these data. The dyadic distance was measured with a narrow beam ultrasonic sensor, wirelessly linked to a laptop. The output of this experiment consisted of the ratio scaled data of 392 participants, equally distributed over the various mask and gender conditions. Depending on pedestrian traffic, the registration of 60 participants for one condition took about 20 minutes.

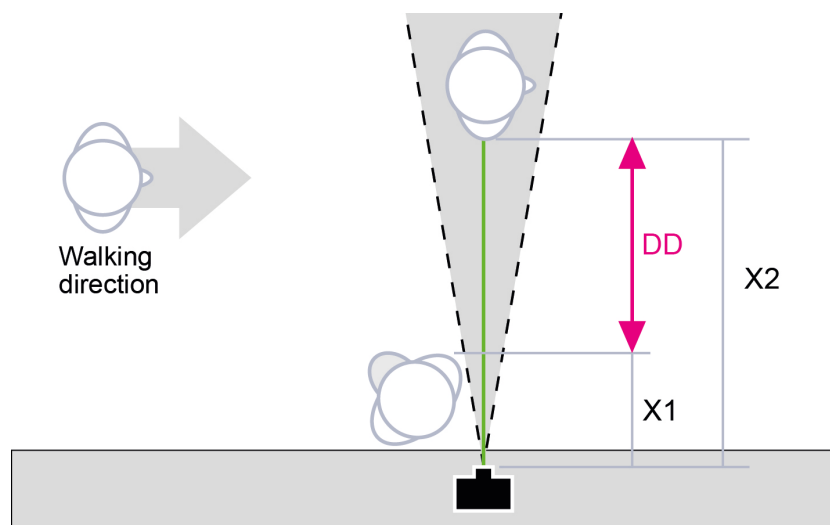


Figure 3. The experimental setup of the Dyadic Distance Experiment and the position of the ultrasonic sensor.

### Equipment

Next to the stimuli, two research partners (one male, one female) and an independent researcher, the DD experiment required the previously mentioned DD-measuring tool and a laptop with DD-software and a Bluetooth connection. The DD-measuring tool was built on an Arduino platform and used a narrow-beam ultrasonic sensor suitable for in- and outdoor use (Maxbotic XL-Maxsonar WRC MB7081). A 9 Volt battery fed the system and to achieve a wireless connection, a Bluetooth module (BlueSmirf Gold) was added to the Arduino board. A switch on top of the housing allowed us to send two different data sets, allowing for a quick changeover between the various conditions. The Arduino board was programmed with PLX-DAQ software and fed its data to MS Excel. The DD-tool is straightforward to build with limited knowledge of electronics and it should not exceed a total cost of \$300.

To avoid the deformation of the measurements, the presence of parking sensors, or other ultrasonic sources needed to be avoided. The DD measuring tool was placed at a distance of about 15 cm in front or next to the research partner (see figure 4).

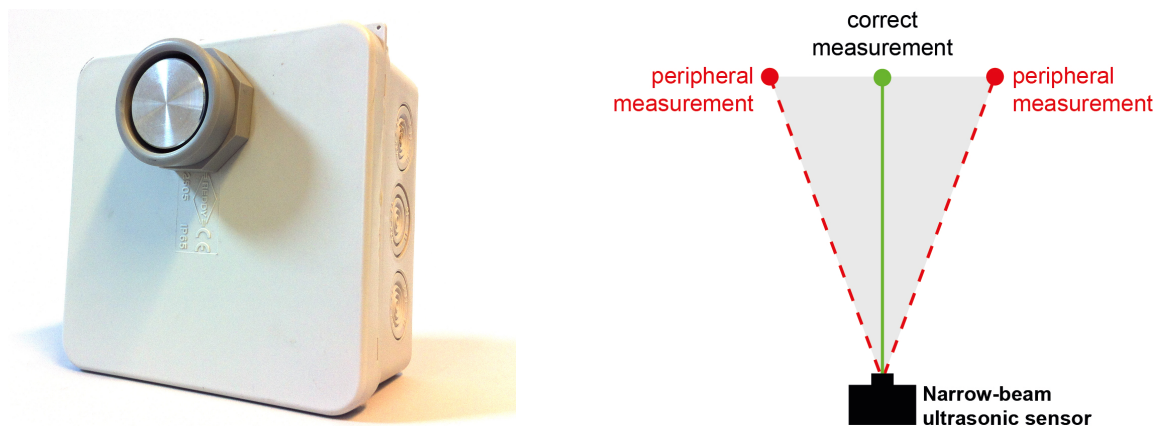


Figure 4. The DD measuring tool

### Procedure

Once the DD-tool was positioned, it followed a specifically programmed calibration sequence to determine the initial distance towards the opposing wall or object. After the calibration session, the sensor takes two measurements per second. It takes about a second for a passer-by to pass through the field of the sensor, resulting in one to three measurements per participant. During the experiment the independent researcher was responsible for the elimination of false or peripheral measurements. This real-time assignment was subtly executed from a distance of at least 5m from the interaction. Analyzing camera images can also do this evaluation. Both methods are suitable as long as they do not influence the experiments.

During the experiment the researcher assigns a gender code to each valid passer-by and selects the correct DD measurement from the set of maximum three measurements (the lowest value), thus eliminating the peripheral measurements of the sensor (figure 4).

For each of the six conditions, at least 30 samples were registered with both a male and a female research partner. In each mask condition/research partner gender combination, male and female passers-by were separately counted and registered (figure 5).

Gender research partner / mask-condition / gender passer-by									
Gender research partner			Mask condition					Total	
			No-mask	White mask	Respro mask	Scarf mask	Proto Transp.		Proto Sport
Male research partner	Gender of passer-by	Male	30	21	23	17	17	15	123
		Female	11	12	10	13	13	15	74
	<b>Total</b>	<b>41</b>	<b>33</b>	<b>33</b>	<b>30</b>	<b>30</b>	<b>30</b>	<b>197</b>	
Female research partner	Gender of passer-by	Male	20	20	19	15	20	24	118
		Female	10	12	19	14	13	9	77
	<b>Total</b>	<b>30</b>	<b>32</b>	<b>38</b>	<b>29</b>	<b>33</b>	<b>33</b>	<b>195</b>	
<b>Total observed participants</b>								<b>392</b>	

Figure 5. Experimental conditions of Dyadic Distance Experiment

### 2.3 Results

Our hypothesis predicts that in an experimental setup, cleared of external influencers, a passer-by will maintain a greater (safer) walking distance from a research partner who wears a dust mask. In addition, it would be interesting to discover significant differences in interpersonal distance between the mask conditions and variances related to the gender of the participants or partners.

Prior to the validation of our hypotheses, we determined whether the gender of the partner or passer-by significantly interacted with the parameter of interpersonal distance.

After analyzing the results of 241 male and 151 female passers-by, a two-way ANOVA, with dyadic distance as the dependent variable, showed no interference between the gender of the passer-by and the mask condition ( $F(5) = 1.794, p = .113$ ).

These results enabled us to derive conclusions related to the different mask conditions that mutually apply to both male and female participants. Adding the male and female samples generated a bigger sample for each condition and increased the accuracy of further statistical analysis. However, for the post-hoc analysis of the variance in dyadic distance among the various mask conditions, it can be interesting to separately evaluate male and female participants.

The DD was measured as portrayed in figure 3 and represented the closest distance between a research partner with mask and a passer-by. The box plot in figure 6 depicts variances in dyadic distance for each mask condition (male and female participants are merged).

Using Fisher’s Least Significant Distance (LSD), a post-hoc analysis compared the mask conditions in pairs and exposed significant interactions between mask pairs. After each LSD analysis, we integrated a visual interpretation of the findings. The figure below each LSD-table visually groups the mask conditions by their average mean dyadic distance. Each group clusters mask conditions for which the mean dyadic distance does not differ significantly.

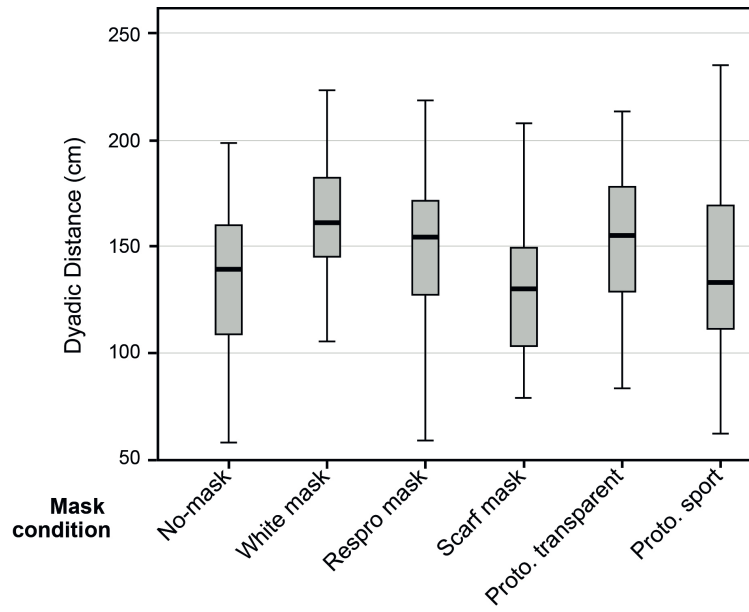


Figure 6. Box plot – Dyadic distance / Mask conditions.

*Result DD-experiment – Male participants*

Analyzing male only participants, ANOVA indicated significance ( $F(5)=3.301, p=0.007$ ) between mask conditions. Post-hoc analysis with LSD rendered the table below, displaying the significant relationships in green. From the 15 possible combinations, five combinations had dyadic distance measures that differed significantly ( $p<0.05$ ) (figure 7).

<b>Significance between mask conditions – only male participants (passers-by)</b>						
	No-mask	White mask	Respro mask	Scarf mask	Trans. proto.	Sport proto.
No-mask						
White mask	0,008					
Respro mask	0,065	0,431				
Scarf mask	0,952	0,012	0,078			
Transparent prototype	0,219	0,191	0,588	0,230		
Sport prototype	0,350	0,001	0,010	0,416	0,045	

Figure 7. Table with the result of the DD-experiment – Male participants.

*Result DD-experiment – Female participants*

Analyzing female only participants, ANOVA indicated significance ( $F(5)=8.916, p<0.001$ ) between mask conditions. Post-hoc analysis with LSD rendered the table below, displaying the significant relationships in green. From the 15 possible combinations, 10 combinations had dyadic distance measures that differed significantly ( $p<0.05$ ) (figure 8).

<b>Significance between mask conditions – only female participants (passers-by)</b>						
	No-mask	White mask	Respro mask	Scarf mask	Trans. proto.	Sport proto
No-mask						
White mask	0,000					
Respro mask	0,020	0,036				
Scarf mask	0,129	0,000	0,000			
Transparent prototype	0,002	0,260	0,343	0,000		
Sport prototype	0,030	0,035	0,928	0,088	0,316	

Figure 8. Table and graph with the result of the DD-experiment – Female participants.

*Result DD-experiment – Male and female participants*

Analyzing both male and female participants, ANOVA indicated significance ( $F(5)=8.677, p<0.001$ ) between mask conditions. Post-hoc analysis with LSD rendered the table below, displaying the significant relationships in green. From the 15 possible combinations, ten combinations had dyadic distance measures that differed significantly ( $p<0.05$ ) (figure 9).

<b>Significance between mask conditions – male and female participant (passers-by)</b>						
	No-mask	White mask	Respro mask	Scarf mask	Trans. proto.	Sport proto.
No-mask						
White mask	0,000					
Respro mask	0,007	0,048				
Scarf mask	0,249	0,000	0,000			
Transparent prototype	0,005	0,088	0,829	0,000		
Sport prototype	0,538	0,000	0,045	0,088	0,031	

Figure 9. Table and graph with the result of the DD-experiment – Male and female participants.

Analyzing the three clustering figures we observed that the following masks conditions appeared in the same group for nearly each situation:

- No-mask / Scarf mask / Sport prototype mask: these three mask conditions engendered the lowest dyadic distance-values in bystanders for each situation (male participant / female participant / male + female participant). The scarf mask had the lowest dyadic distance value, followed by the no-mask condition.
- Respro mask / transparent prototype: both these mask conditions scored mid-range values.
- White mask: the white mask scored the highest average dyadic distance in each situation and was clustered with the transparent prototype.



## *2.4 Discussion Dyadic Distance Experiment*

The result of the DD-experiment led us to infer that avoidant behavior of passers-by towards users of dust masks, expressed by the dyadic distance parameter, can be measured. The average dyadic distance between the white mask and the no-mask reference condition differed about 30 cm. In contrast with our expectations, the no-mask condition did not engender the smallest dyadic distance. The scarf mask generated the smallest dyadic distance in each condition. The other mask conditions all differ about 15 cm from the no-mask reference condition.

The most general and valuable conclusion from the DD-experiment was the detection of three groups of masks that revealed no reciprocal significance.

The results of our subsequent exploration, the Stain Dilemma experiment, will either confirm or disconfirm these initial findings. Because both experiments were set up to be comparative, we will elaborate on the final results of both experiments in a joint discussion and conclusion paragraph at the end of this paper.

## **3. The Stain Dilemma Experiment**

### *3.1 Experimental stimuli, setup and participants*

The experimental setup, location, stimuli and participants are identical to the DD-experiment (See paragraph 2.1).

### *3.2 Method*

The measurement of interpersonal distance with the dyadic distance technique delivered an accurate dataset for each mask condition. The next experiment focuses on the thoughtful and unconscious decisions that are made during a social interaction. When we walk around, our brain is constantly scanning and analyzing our visual surroundings. In 1971, Goffman already pointed out that the study of walking behavior might deliver interesting insights in the study of social stigma.

The 'Stain Dilemma' experiment reduces the input variables to a minimum and focuses on the walking path of the bystander as he passes a person who uses or wears a stigma-eliciting product. By placing a physical obstruction in the walking path, the passer-by is forced to walk around the obstruction or in between the obstruction and our research partner.

The avoidance of a stain has a lot to do with common sense, fear of mess and possible slipping. We were not primarily interested in the avoidance of the stain, but on the uncomplicated and effortless choice that is presents to the passer-by. However trivial this dilemma might appear, it proved to have an influence on the choices and behavior of the passer-by.

### Equipment

The 'Stain dilemma experiment' requires little equipment and setup. The most crucial object is the physical obstacle that is introduced in the walking path. The obstacle was to be easily detectable, without being suspicious or alarming. In city life, pedestrians are often confronted with unpleasant spills and obstacles on the sidewalk. The experiment relies on the pedestrians' subtle awareness of these familiar obstacles, and their intent to avoid them in an almost routinely way. Because our experiment was setup close to the railway station, in the presence of many food and beverage stalls, we chose to imitate a spilled milk shake. We avoided the use of unpleasant animal or human droppings to avoid any negative connotations with our research partner. This connection could activate unwanted disease avoidant behavior in the passer-by. A spilled milk shake is no anomaly on a city sidewalk and does not allocate many cognitive resources as the passer-by approaches and avoids it. We labeled our obstacle the 'fake shake' and positioned it on the border between the personal and social space (Hall, 1996) surrounding the research partner.

### The 'fake shake'

The 'fake shake' is a realistic imitation of a strawberry milkshake, including cup and straw (see figure 10). We chose a bright and contrasting color to increase the chances of visual perception. The shake is made from a mixture of acrylic paint and other additives to give it the right texture, solidity and shine. A plastic cup and straw were added to increase the reality of the object.



Figure 10. The 'fake shake'.

For visual reference and in order to collect 'rich'-data, the experiment was registered with an invisible HD camera. The camera registered the passers-by as they approached our research partner (see figure 11). In its most elementary version, data collection requires no more than a pencil and a piece of paper. Additionally it is possible to develop a smart phone application for easy mobile data registration and analysis.

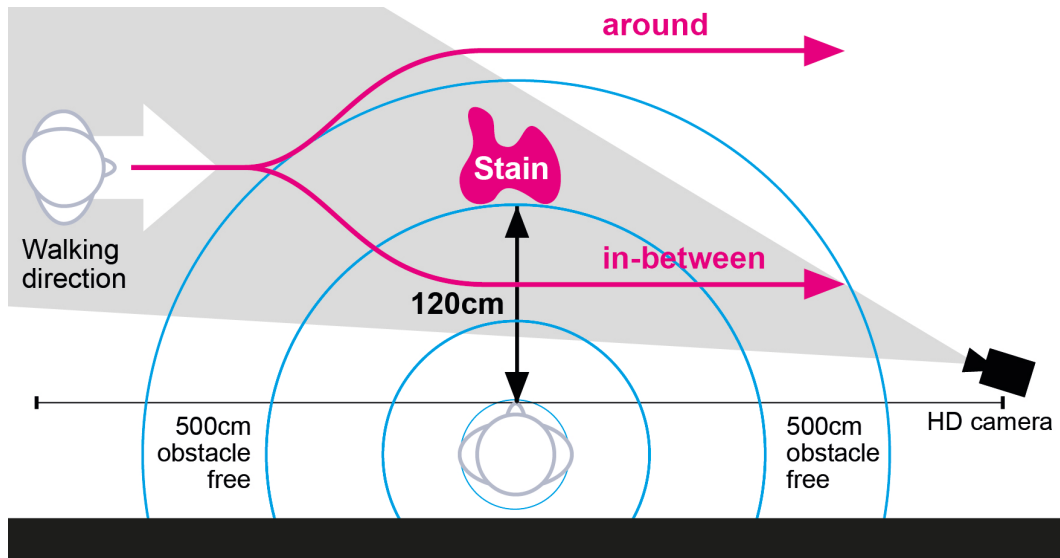


Figure 11. Experimental setup of the Stain Dilemma experiment.

### Procedure

To qualify as a valid participant, a passer-by had to singly approach our research partner, without being obstructed during the full length of the interaction process. As with the DD-experiment, both male and female participants were recorded. The amount of participants averaged about 40 for each mask and gender condition, bringing the total amount to 480 participants (see figure 12).

Data registration was limited to two variables: the gender of the passer-by (male or female) and the path (around the stain or in between stain and partner).

Gender research partner / mask-condition / gender passer-by			Mask-condition						Total
Gender partner	Gender passer-by	Reaction passer-by	No-mask	White mask	Respro mask	Scarf mask	Proto transp.	Proto Sport	
Male research partner	Male	Around	13	20	11	19	15	17	95
		In-between	11	3	10	9	7	7	47
		<b>Total</b>	<b>24</b>	<b>23</b>	<b>21</b>	<b>28</b>	<b>22</b>	<b>24</b>	<b>142</b>
	Female	Around	11	11	14	9	9	13	67
		In-between	5	6	5	3	9	3	31
		<b>Total</b>	<b>16</b>	<b>17</b>	<b>19</b>	<b>12</b>	<b>18</b>	<b>16</b>	<b>98</b>
Female research partner	Male	Around	6	20	17	16	12	13	84
		In-between	13	1	9	12	12	11	58
		<b>Total</b>	<b>19</b>	<b>21</b>	<b>26</b>	<b>28</b>	<b>24</b>	<b>24</b>	<b>142</b>
	Female	Around	8	18	10	9	9	11	65
		In-between	13	1	4	3	7	5	33
		<b>Total</b>	<b>21</b>	<b>19</b>	<b>14</b>	<b>12</b>	<b>16</b>	<b>16</b>	<b>98</b>
<b>Total observed participants</b>									<b>480</b>

Figure 12. Experimental conditions of Stain Dilemma Experiment.

### 3.3 Results

The hypothesis of the stain dilemma experiment predicted that when a mask is appraised as stigma-sensitive, a passer-by will actively avoid entering the personal space of the research partner. By walking around the stain, through the social space, a passer-by demonstrates that he prefers to avoid the user of the dust mask.

As was the case with the DD-experiment, we analyzed additional differences between the mask conditions and variances related to the participants or research partners' gender.

The influence of the partner's gender on the participant's reaction (around/in-between) was analyzed with a chi-square test with continuity correction. Only the no-mask condition displayed significant interaction between gender and reaction.

Further analysis was performed on the combined samples of male and female partners.

#### Result stain dilemma experiment – Male and female participants separately

After analyzing the result of 284 male participants, a chi-square test with continuity correction revealed no significant differences in the reactions to the different mask conditions ( $\chi^2(5)=5.470$ ,  $p=0.361$ ). The results of the female participants (196 samples) did reveal significant differences in reaction ( $\chi^2(5)=33.011$ ,  $p<0.01$ ). We especially noticed the apparent result for the white mask condition. Only 2 out of 40 female participants felt comfortable to enter the personal space of the wearer of the white dust mask (figure 13).

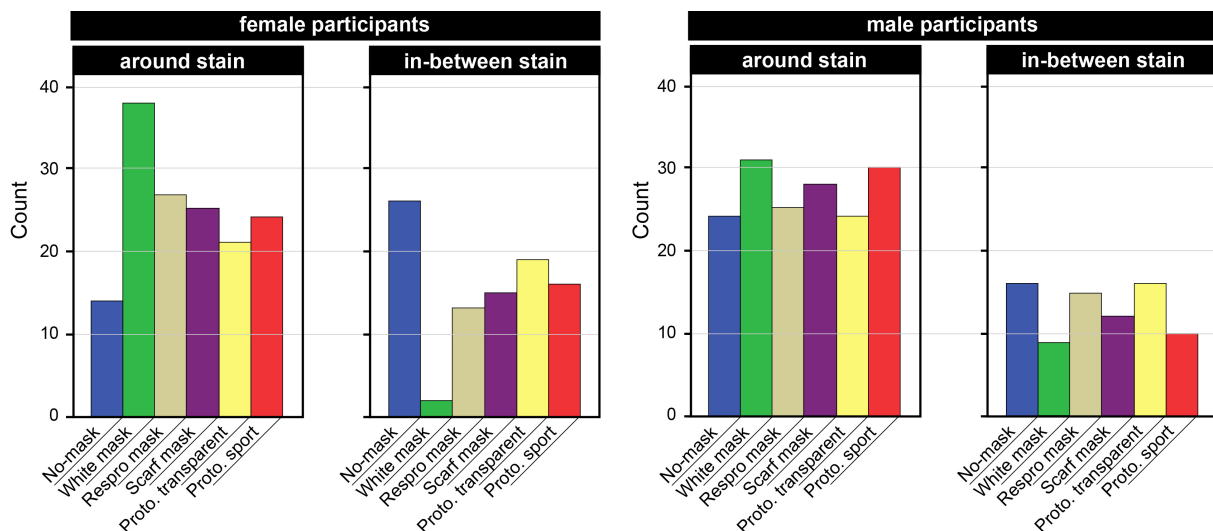


Figure 13. Count around and in-between stain for female and male participants separately

#### Result stain dilemma experiment – Male and female participants combined

The results of the combined analysis of male and female participants (480 samples) are visualized in the bar-diagrams of figure 14. A chi-square test with continuity correction for the entire sample (male + female participants) indicated that the participant reactions

differed significantly for certain mask combinations ( $\text{Chi}^2(5)=29.526, p<0.01$ ). A two-sample proportion test was used to disclose the proportional differences in reactions towards the different mask conditions. To reduce type 1 errors, the alpha value was lowered to account for the cumulative effect of the different mask combinations ( $\alpha = 0.05/(5+4+3+2+1) = 0,0034$ ). The table below displays the significant differences in proportion between the mask combinations ( $< 0,0034$ ). Similar to the analysis of the DD-experiment, the results of the analysis allowed for a clustering of mask conditions that did not reveal significant interaction among each other. The clustering revealed three groups. In a first group we situate the no-mask and transparent mask conditions. For both these masks participants felt most comfortable to enter the personal space of the mask wearer, i.e. between stain and mask wearer. A second group bundles the scarf mask, sport prototype, and Respro mask. The white mask condition is isolated from the other conditions, with 69 out of 80 passers-by walking around the stain.

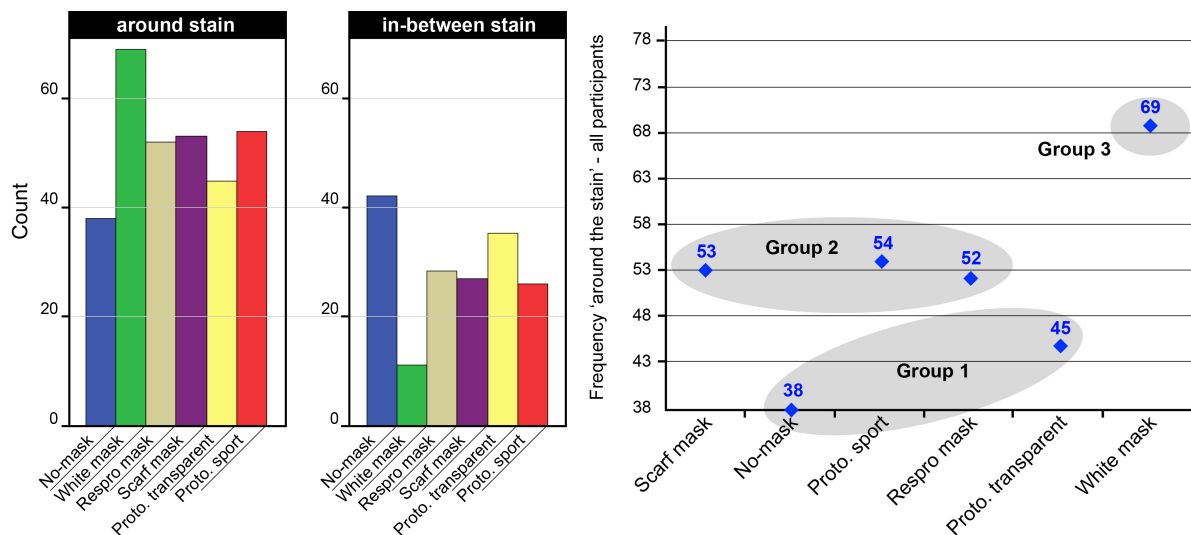


Figure 14. Count around and in-between stain for female and male participants combined / Visual grouping of the count 'around the stain' for all participants and mask conditions

### 3.4 Discussion Stain Dilemma Experiment

The results of the stain dilemma experiment revealed significant proportional differences in the reactions to the no-mask and white mask conditions. The other mask conditions positioned themselves in between these extremes.

Although the analysis of the reactions of the male population did not reveal significant differences, we mention that in four out of six conditions their reactions scored proportionally higher in comparison to the female participants. This could indicate that in general passers-by are less inclined to enter the personal space of male individuals.

#### **4. Discussion of Dyadic Distance and Stain Dilemma Experiment**

Both experiments illustrated that they can be effective in assessing and measuring avoidant behavior of bystanders towards dust masks. A remarkable observation was that the average interpersonal distance as well as the proportion of people walking around the stain was always greater in a setup with a male research partner. Male research partners, independently of the mask they wore, always seemed to increase avoidant behavior in bystanders. Literature in social psychology confirms such behavior around men and suggests that it is linked to the social power or menace engendered by the male species (Dabbs & Stokes, 1975). This passive 'force' endues men with a greater social space and could clarify why passers-by will maintain a greater distance from them. Because our experiments only allowed for an avoidance area of no more than 320 cm, this effect compressed the 'comfort zone' around our male research partners. This effect has to be taken into account in future explorations.

In an analysis of the mask groupings that were made for both experiments, it is possible to determine areas of convergence between the different mask conditions.

Figure 15 represents the results from both male and female participants. The horizontal axis represents the DD-experiment and indicates the average dyadic distance for each mask condition. The scale starts at 120 cm, which is the border between the personal and social space (Hall, 1966), and runs up to 170 cm.

The vertical axis represents the Stain Dilemma experiment and indicates the relative count of passers-by walking around the stain. The scale starts at 38, which is the amount of passers-by who walked around the stain in the neutral condition. Because the samples for each mask condition were identical in the stain dilemma experiment, the count can be interpreted as proportionate.

Figure 15 aims at visualizing the 'degree of acceptance' or the 'degree' of product-related stigma of a mask type with the aid of a gradient scale. Products that reside in the green part are considered to be acceptable, resulting in a regular interpersonal distance. As a product migrates to the red area, it becomes less accepted, accompanied by a greater dyadic distance and a larger number of people walking around the stain. If a product ends up in the grey zone, close to the axes, the validity of the results should be questioned, because this would mean that the results of the two experiments are opposed, which is unlikely. The gradient representation allows for a straightforward interpretation and communication of the experimental findings, ideal for meetings with stakeholders.

The combined visualization in figure 15 also aids in exposing inconsistent results for certain mask types. The further a product moves away from the centerline, the less consistent its experimental results are. A mask can score a low average dyadic distance, together with a high number of passers-by walking around the stain, and vice versa. A closer look at the instances prior to visual contact could clarify these findings.

If there are no striking features that visually alert a passer-by, he or she will approach the mask wearer as a 'normal' person. In this situation it is plausible that the decision to divert from the walking path will be made at the last moment. This could explain why the scarf mask, which nicely blends with its surroundings, engenders a low dyadic distance measure, combined with a high count of people walking around the stain. The scarf is only noted as unnatural or awkward when the passer-by is relatively close, promoting his 'last-minute' decision to walk around the stain. An opposite scenario can be observed for the transparent prototype that combines a substantial dyadic distance with a low count of people walking around the stain. Due to its brightly colored edge and its medical-like transparency, this mask has the potential to attract attention from a greater distance, a possible explanation for the greater dyadic distance. However, the soft looks and the visibility of facial features might comfort the passer-by as he or she approaches. These traits will increase the 'warmth' dimension of the wearer, encouraging the passer-by to pass between the stain and the mask wearer when forced to make a 'last-minute' decision.

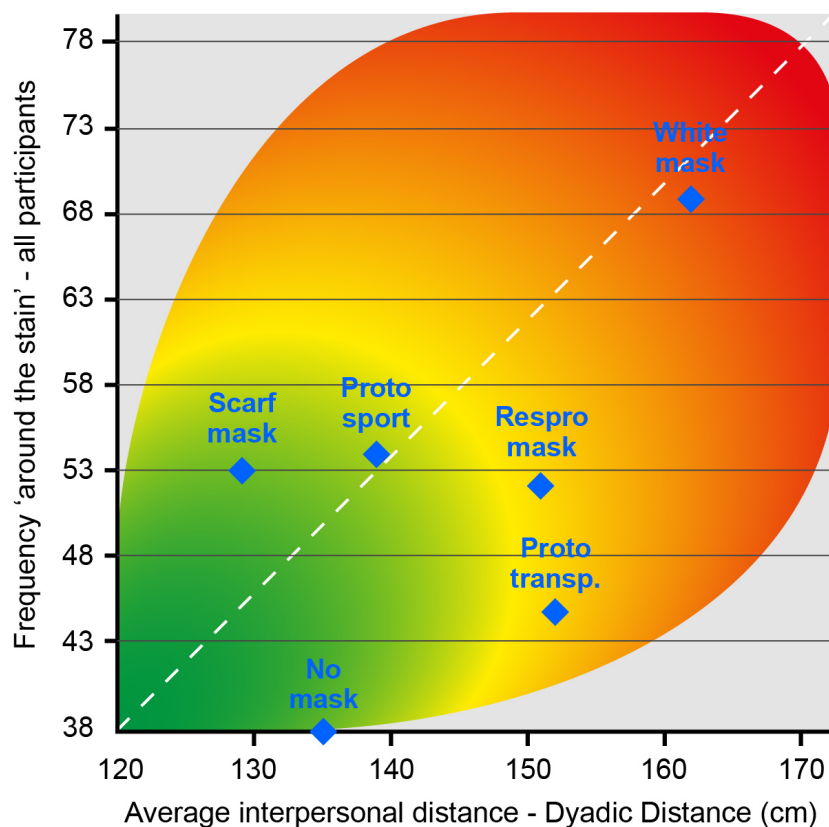


Figure 15. Combined experimental results: proportion around the stain x average interpersonal distance.

## **5. Conclusion**

Both experiments prove that it is possible to measure significant differences in the behavioral reactions of bystanders towards users of stigma-sensitive products. The results suggest that the interpersonal distance between the product user and those who pass them is a valuable measure to quantify the 'degree' of product-related stigma.

We suggested that an accurate detection of the interpersonal distance could be obtained with a perpendicular measurement received from an ultrasonic sensor. We labeled this parameter the 'Dyadic Distance' and our experimental findings suggested that registering 30 participants for each human-product condition should suffice. The average dyadic distance between a passer-by and user of a white mask, compared to the no-mask reference condition differed about 30 cm.

The stain dilemma experiment can be interpreted as a simplified as well as a complementing experiment. An eye-catching stain positioned on the border between the user's personal and social space, forces passers-by to choose a path. The path around the stain presents the 'safe' option, indicating the desire to avoid the user and his product. The path through the user's personal space will be chosen when passers-by feel comfortable around the user/product combination. Because the stain dilemma experiment only renders binary results, it requires a larger sample for each condition. We advise to sample at least 40 participants for each human-product condition.

The experiments are conceptualized for efficiency (in time and resources) and allow for testing in a public setting that approaches real-life conditions.

Both experiments do not aim to deliver meticulous data by which stigma-sensitive products can be accepted or rejected. Nor do they provide the designer with exact information on which design features engendered the recorded reactions in bystanders. Nevertheless, these experiments have proven to be valuable in ranking a set of design proposals or products. By exposing products on a user, in realistic settings, and subjected to a large number of passers-by, the experiments can provide quick and valuable insight for designers.

We do note that the cultural setting will influence the results. As such, experimental findings cannot be extrapolated outside the cultural setting in which the experiment is setup.

During our experimental explorations we focused on the reactions engendered by existing dust masks as well as early prototypes. In future iterations, we would like to explore the relevance of our experimental techniques for other stigma-eliciting products that are visual to bystanders, such as crutches, prosthetics, hearing aids, etc. Apart from measuring product-related stigma elicited by protective, medical and assistive devices, the techniques we have applied could have a wider range of applications, e.g. in fashion, for wearable technology and law enforcement products.



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