From Mental to Visual Image: An Iterative Method for Designing Pictograms to Promote the Understanding of a Drug Treatment

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Abstract. Taking medication requires several precautions. The use of pictograms, when accompanying prescribed pharmacotherapy, is considered as an effective way to facilitate the understanding of sensitive populations (e.g., elderly people, low literacy levels, migrants, etc.) regarding their pharmaceutical treatment. However, the essential condition is to provide a set of pictograms which is easily recognized by medicine users. This supposes that those health visual tools should be designed in accordance with the users' visual representations of the pharmaceutical information. To test the identification of pictograms designed from mental images, we conducted two studies. In the first study, fifty-two participants were asked to draw their mental images associated with information contained in medication leaflets. The corpus of drawings conducted to the design of pictograms that were then submitted to a comprehension test among a new population (N = 116) in a second study. It appears that the most frequent mental images are those that are best identified once they have been transcribed in the form of pictograms.

These findings, which corroborate the link between mental and visual images, invite to consider the use of pictograms to promote understanding of drug treatment on the one hand, and to integrate drug users in the process of designing pictograms on the other.

Keywords: "Mental images" · "Pictograms" · "Medicine" · "At-risk populations"

1 Introduction

Patient's rights in France are guaranteed by the Public Health Code and emphases the necessity for a clear, fair, and appropriate therapeutic information toward the patient. Medical information are usually transmitted orally during a consultation, a home visit, or at the pharmacy. However, some factors may prevent the transfer of knowledge from being transferred from the health professional – the expert – to the patient, who is, in this social context, a layperson. A study conducted by Fainzang [1] shows that the verbal description of ailments and symptoms can be influenced by social assets such as cultural capital, or literacy level. Meanwhile, on the health professional's side, the representation of the patient's social environment can impact the transmission of scientific information

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on the patient's health status. Thus, patients from higher social categories would be perceived as being better able to understand, but also to handle the medical information provided by the physician than patients from the lower social categories. When the visit at the doctor leads to a prescription, patients can then rely on the package leaflet, inserted inside medicine boxes to learn about his treatment. However, only 54% of medicine users systematically read the leaflet of the drug they are taking[1] depending on their knowledge of the drug [2], their gender, their age [3], or their socio-professional category. Package leaflets are commonly considered as long, and tedious to read [4–6]. They also may lead to misinterpretation of drug treatment [7, 8] particularly for patients with the lowest levels of health literacy [9], illiterates [10] and seniors [11]. As one of the factors of therapeutic adherence is a good understanding of the disease and its associated treatment [12], these factors lead to consider the use of additional tools to make easier the expression of ailments during the communication, but also a better communication of medicine information. One way to ensure that medicine leaflets are understandable by a large majority of individuals, including sensitive groups who encounters reading issues, could be the use of visual signs (i.e., pictograms).

2 Health Pictograms to Enhance Medication Use

Health pictograms open an interesting avenue for reducing medication administration errors. A meta-analysis [13] concludes that images generally have a positive effect on attention, comprehension, memorization, and even therapeutic adherence compared to the text alone [14]. However, in his study of image perception among non-Western individuals, Hudson [15] showed that image understanding mainly depends on socio-cultural factors such as schooling and urbanization. In addition, other research has identified comprehension issues due to image interpretation [16]. Health pictograms, which are designed to ensure user safety, must be given special attention. However, according to Bordon, "because of the presumption that an iconic sign is universally understandable, it is not customary to test the reception of a new pictogram" [17]. Similarly, the meta-analysis of Beusekom et al. [7] concluded that few studies on the use of pictograms associated with drug treatment involve the role and decision-making power of the users concerned by this medium. This lack of feedback from the users themselves lead to forget the mediating role of their mental images in the design of pictograms. Yet, the isomorphism between mental images and visual images seems to lead to a better interpretation of visual images. Indeed, in Cohen's thesis [18], participants were asked to draw their mental images associated with the drug. This inductor conducted to many drawings, including a green cross to represent a pharmacy. Another population was then instructed to select the most representative image of a pharmacy from three different photo: a pharmacy, a caduceus, and a green cross. The results showed that the green cross was statistically considered to be the most representative of the pharmacy, compared to the other two images. This finding suggests that a visual image of a verbal or written information has a better chance to be understood if it complies with the mental image the given information produces.

[1] According to an Ipsos survey conducted in 2014.

To explore the presumed link between the production of a mental image and the understanding of a health pictogram complying to this mental image, two studies have been conducted. In the first study, mental images associated with therapeutic information have been collected. In the second study, pictograms designed from those corpus of mental images were assessed by a new population.

3 Study 1

3.1 Method

The participants of this first study ($N = 52$, 17 men and 35 women) were recruited from a Technical University Institute, and in a workshop for learning the French language in the South of France to ensure the literacy levels' heterogeneity of the surveyed population.

Seven information were extracted from the leaflets of the three most popular medicines in France. These were divided into three categories:

- Symptoms (i.e., "this medication is indicated in case of dental pain"; "this medicine is indicated in case of fever"; "this medication is indicated in case of cough")
- Dosage ("this medication must be taken in the evening"; "this medication must be taken before bedtime"; "this medication should be taken during meals")
- Side effect ("this medication may cause drowsiness or fatigue").

Participants were given pencils, erasers, felt pens, and a booklet in A5 format that contained on each page one of the seven drug information. They were asked to draw the mental image that spontaneously appeared in their mind when reading each information. For some participants (i.e., the less literate ones), the written information needed to be explained orally so the information could be understood and then drawn. This was done with the help of a trainer, who was asked to read the information and in some cases explain the information with terms other than those used in the booklet. She was nevertheless forbidden to mimic the information as it could bias the mental image production among the population.

3.2 Results

52 drawings per information were collected, giving a total of 364 drawings. The data were explored through the content analysis method suggested by Bardin [19], which consists in making a "floating" reading of the corpus. The first step of this process consists in having a global reading of the corpus to become familiar with the data. Through this approach, the forms that were the most often used by the participants associated with symptoms, dosage, and side effect were identified. We then listed the shapes contained in the drawings and isolated them one by one. For instance, regarding "this medicine is indicated in case of fever" information, if participant 16 drew a face whose forehead and cheeks are colored in red, and a thermometer, each of these forms (i.e., a character; red cheeks and forehead; sweat; thermometer) listed in a table. If participant 23 drew a sweating face and a thermometer, then we added the thermometer form, and added for

Table 1. Most Common Forms According to the Information Type

Information	Principal pattern	Secondary pattern
Dental pain	Teeth close-up	Red cheek on face
Fever	Red cheeks and forehead	Thermometer
In case of cough	Someone spitting	Red neck
Taken in the evening	Sunset and skyline	Clock
Take before bedtime	Moon	Bed
Taken during a meal	Cutlery	Individual and Table
Causes drowsiness or fatigue	Closed-eyed	Bed
Average expression of the form	29	16,7

the sweat drops' shape as supplementary columns. For each of the seven information, the two most frequent combinations of shapes (i.e., a pattern) were retained, as seen in Table 1.

Half of the participants drew an open mouth to reveal teeth to represent toothache. Some symbols, such as arrows or lightning bolts could be used, but also onomatopoeias (e.g., 'ouch'). These connotative elements were usually around a single tooth. 19 participants focused on the cheeks, by creating a swelling effect and/or coloring them in red. The drawn character sometimes carried his hand to his mouth, whether it concerns the main or the secondary pattern. "This medication is indicated in case of fever" indication was mainly represented (35 drawings, or 67.3% of the corpus) by certain face parts– cheeks and/or forehead – drawn in red. The other most expressed form was the thermometer (22 drawings). This was usually accompanied by the number "38", corresponding to the hyperthermia threshold. For 31, or almost 60% of the study participants, "this drug is indicated for coughing" was indicated by expelled sputters, while the second most drawn form (14 expressions) is the red-colored neck area. Regarding the drawing associated with dosage, "this medication must be taken at night" information is represented by either a sunset and a skyline (23 drawings) or a clock (16 drawings). The sleeping time is symbolized by the moon and the stars (27) or by an individual lying in a bed (14). Taking the drug with a meal is represented by cutlery or an individual near a table (28 *versus* 17 drawings). The risk of drowsiness or fatigue was personified by an individual with closed eyes or by an individual bedridden (33 *versus* 15 drawings).

The analysis of this drawing corpus resulted in the design of two pictograms per information, based on the principal and the secondary pattern (i.e., the two most drawn patterns by the study population). We referred to the ISO 7010 standard, which deals with graphical symbols related to user safety.

1. The meaning given is opposite to that provided for
2. The answer is wrong
3. Participant does not know
4. Participant did not respond

In order to make it easier to read the results expressed, we have grouped categories 2 to 6 as they reflect a low understanding of the pictogram. The absence of a response (category 7) leads to an exclusion of data processing.

4 Study 2

4.1 Method

116 students (M*age* = 21.9; SD = 3.7), recruited on social networks, were asked to identify the meaning of the pictograms. The instruction was "As part of the design of a series of pictograms to improve understanding of a drug treatment, write down what each pictogram represents according to you". Participants were divided into four groups (of which the number of participants for each group was between 26 and 31) and met only one part of the pictograms. Responses fell into one of the following categories:

In order to make it easier to read the results expressed, we have grouped categories 2 to 6 as they reflect a low understanding of the pictogram. The absence of a response (category 7) leads to an exclusion of data processing.

4.2 Results

A χ^2 test of independence was carried out to compare the distribution of responses (identification of correct or incorrect health pictogram) according to the pattern (principal or secondary) presented to the participants (Table 2).

Table 2. Identification of drug information by principal or secondary pattern. ** $p < .01$; *** $p < .001$ (Chi-square test of independence).

Information	Principal pattern	Identification (%)	Secondary pattern	Identification (%)	Significance
Dental pain		3.8		66.6	***
Fever		45.1		96.5	***
Cough		90.3		0	***
Take in the evening		66.6		3.8	***
Take before bedtime		65.4		16.1	***
Taken during a meal		86.6		40	***
Causes drowsiness or fatigue		76.6		41.9	**

The results indicate that the first information (i.e., "this medication is indicated for dental pain") is less understood when it is represented by a close-up shot on the mouth (principal pattern), in comparison to the representation of a red area on the cheek (secondary pattern), χ^2 (1, N = 56) = 23.45, p < .001. In most cases, when exposed to this pictogram version, participants wrongly believed that the main pattern were associated to an oral administration of the drug.

Considering the fever pictogram, the results indicate that the information is better understood when represented by a thermometer (secondary form) than by areas of the face-colored red (principal form), χ^2 (1, N = 59) = 17.89, p < .001. For 54.9% of participants exposed to the main form, it leads to errors in interpretation of symptoms. Indeed, when it comes to guessing what red areas on the face might look like, the pictogram is often associated with headaches, hot flashes, or even rashes.

The two visual representations of cough also do not lead to the same interpretations, χ^2 (1, N = 60) = 52.5, p < .001. While 90.3% of the population identifies the right symptom when exposed to the principal pattern, the secondary pattern – the red neck – is systematically wrongly associated with sore throat.

The information that the drug should be taken in the evening is significantly better understood when represented by a sunset and a skyline rather than a clock, χ^2 (1, N = 56) = 23.45, p < .001. Response analysis indicates that the clock generally leads to a wrong interpretation (i.e., "the medication must be taken at a precise hour").

Regarding the bedtime pictogram, there is a statistically significant difference between the moon and the bedridden individual, χ^2 (1, N = 57) = 14.47, p < .001. This latter form has generated many interpretations related to a side effect resulting the drug absorption (e.g., "the drug makes you sleep"; "sleeplessness risk"), the indication (e.g., "sleep medicine"; "hypnotic") or induced the opposite interpretation ("to be taken upon awakening").

The pictograms representing the information that the medication should be taken at mealtime were significantly better understood when depicted by cutlery than by an individual next to a table, χ^2 (1, N = 60) = 14.07, p < .001. In the last case where the figure stands next to the table, this pictogram was several times interpreted by the fact that the intake should be done before or after the meal and not during it, which is a misunderstanding.

Finally, the side effect of drowsiness or fatigue following drug intake was more associated with the face of an individual with eyes closed rather than a bed, χ^2 (1, N = 60) = 8.72, p < .01. Several misinterpretations of the secondary pattern were also found due to the expression of bed, including that the medication should not be taken at night but only during the day.

According to the International Organization for Standardization (ISO) 9186–1:2014 standard for graphical symbols, the identification score of a pictogram must be understood by at least 67% of the users, without explanatory text, to be considered as acceptable. Hence, 6 out of 14, or 42.8% pictograms from the present study could be standardized.

5 Discussion

The aim of this study was to explore mental images about health-related information, as well as their impact on interpretation of pictograms. The data analysis of the iconographic association task (see study 1) implies the existence of a collective imagery concerning the care process. Although the drawings produced in our study seem to transcribe individual experiences associated with symptoms, we found common characteristics in some drawings such as the use of the close-up when depicting symptoms (see Fig. 1).

The purpose of this technique is to draw the viewer's attention to the characters, and more specifically to their facial expression, as they reflect their emotions. In the present study, we assume that the participants wanted to focus attention on the expression of emotions considered as the most relevant to objectify the given symptom, such as pain (e.g., tears, squinting eyes) or sadness (e.g., corners of the mouth turned downward).

Participants also used symbolic techniques to draw attention to the area concerned, such as coloring a sore area in red (cf. Figure 1), using lines to show the irradiation of a sore area, or allegories. For example, the only representation of a fork and a knife corresponds to the meal script, indicating that the treatment should be taken on this occasion (see Fig. 2).

Graphic stereotypes were also used by the study population of Green & Ashmore [20], who asked students to form mental images based on a typology of eight profiles, such as the housewife, and a businessperson. In the first case, the housewife is usually represented in action (i.e., carrying out a household task) in a comfortable outfit, whereas in the second case the individual described is mostly a male figure wearing a suit in a static position. If these graphic stereotypes highlight the question of the relationship to pathology on the one hand, and gender stereotypes on the other hand, they more generally support the idea that a verbal information can easily be associated with an image and that this association is shared between individuals from the same culture. Nevertheless, a recent study [21] showed that the level of abstraction of a drawing varies according to the level of literacy: the highest levels of literacy are more prone to express graphic symbols (onomatopoeia, arrows, personification, etc.) than those with a low level of literacy. For instance, when asked to draw a man and a woman, participants with the highest literacy levels tended to use the symbol of the God Mars (i.e., a shield and an

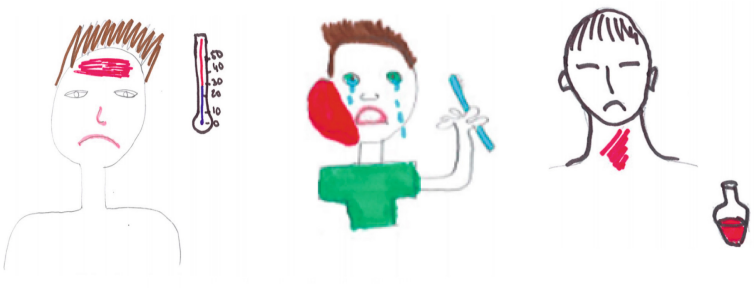

Fig. 1. Close-up on characters suffering from three different symptoms: toothache, fever, and cough.

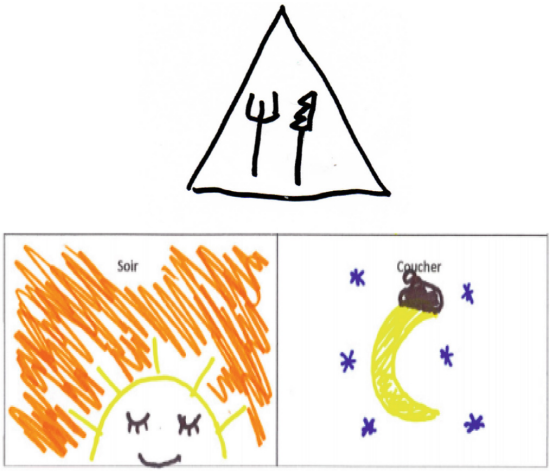

Fig. 2. Symbolic expressions associated with treatment dosage: should be taken with meals, should be taken in the evening, should be taken before bed.

arrow) and the Goddess Venus whereas the participants with the lowest literacy levels were more likely to draw stereotypical gender attributes (e.g., a man with a beard, and a woman with long hair wearing a dress).

The graphic dimension preference, in one case symbolic and in the other case analogical, leads to question the standard procedures for designing pictograms, as the results of Study 2 suggest a link between mental and visual images. In other words, a pictogram indicating a given piece of information is likely to be better identified when conforming to the mental image of the oral or verbal information. It can be assumed, therefore, that the most analogous pictograms will be best understood by populations with low literacy skills. However, the analogical aspect of a sign depends on the concreteness of the information (i.e., its degree of abstraction). In some cases, the most symbolic signed need to be learnt. Since pictograms have a higher efficacy than simple text on a drug treatment comprehension, especially for the lowest literacy levels [22], these findings suggest that the most sensitive populations should be invited to the standardization processes within the different stages of a health pictogram design.

6 Conclusion

Since 2014, Article R5121-149 of the French Public Health Code allows signs or pictograms explaining information such as therapeutic indications, instructions necessary for the proper use of the drug, dosage, etc. Unfortunately, there are still two obstacles to ensure the democratization and the optimization of this visual aid. Firstly, this initiative is not widely followed despite of many study conclusions attesting to the effectiveness of pictograms in promoting understanding of drug treatment [23, 7, 24). Secondly, only a few studies involve end-users during the design process [6], whereas this participatory

approach would ensure that pictograms are consistent with patients' images of therapeutic indications. The iterative pictogram design methodology suggested in this study invites to consider the essential mental image users' role in the pictogram design.

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Authors' Contributions. The author designed and managed the study, analysed, interpreted the data, and wrote the manuscript.

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