Adaptive device for disease awareness and treatment adherence of asthma in children

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1. Introduction and context

In 2006, a national study revealed that there were 4,15 million of people with asthma in France, which represented 6,7% of the population (Afrite, Allonier, Com-Ruelle, & Le Guen, 2011). This chronic disease had generated 43 000 hospitalizations between 2005 and 2007 (Fuhrman et al., 2011). Nowadays, it is stillresponsible for 1000 death annually (Tual, Godard, Bousquet and Annesi-Maesano, 2008). Asthma is the first chronic disease in children: that concerns 10% of them (Darras&Demoly, 2006). This is a real public health issue, because its frequency and gravity increase since 2000's in this specific population (Delmas et al., 2014).

The mainidentified problem in asthma kids is the low rate of treatment adherence. Indeed, only 50% of them are taking their treatments as prescribed (duration, dosage…), and adopts healthy behaviors to avoid symptoms or crisis (de Blic, 2007). Moreover, 26% don't control their asthma, i.e. they can have crisis whenever (de Blic et al., 2009).

2. State of the art

To increase adherence rate, there is some strategies as therapeutic education programs (improve disease knowledge and management) (ANAES, 1998) and numerical technologies as serious games (Bronkie the Bronchiasaurus(Kato, 2010; Lieberman, 2001), …) or mobile applications (My Asthma Pal (Abril, 2015), …), but they all focus on short-term results. Furthermore, those learning systems are the same for all children, and it is proved that personalized program is more efficient than generic learning (Lopes, Clement, Roy, & Oudeyer, 2014).

3. Objectives and Methods

This thesis project, in collaboration with Inria Flowers Team,have the objective to create a personalized tool, named *KidBreath*, which is based on processes used in therapeutic education forchildren from 8 to 11 year old.Our easy to use solution is available on computers and tablets, and is design to allow children to use it autonomously.
KidBreath is composed by severalinteractive contents linked to asthma and displayed to different forms: learning activities with quiz, short games and videos. Asthma experts like health educators, pulmonologists, and pediatricians validated all the proposed content in the application.
The main goal of our project is to improve disease awareness. For this, we will care aboutthreesub-components: usability, knowledge and motivation.

3.1. Usability

The interfaces are tailored to children. Indeed, they had beendesigned with iterative and user-centeredmethods such as:

- Participative workshops with children(Newell & Gregor, 2000),
- User tests(Daumal, 2012)
- Gamification features, for example:choose your ownavatar (Fig.1) or visualize your performance evolution (Fig.2) (Mulletier, Bertholet, & Lang, 2014).

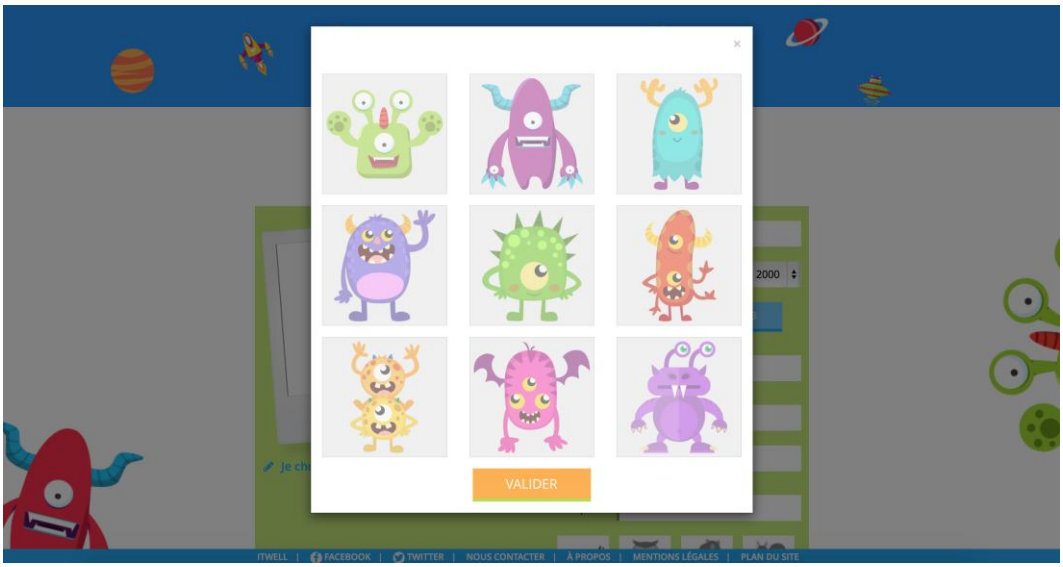

Fig.1: Choice of avatar during inscription

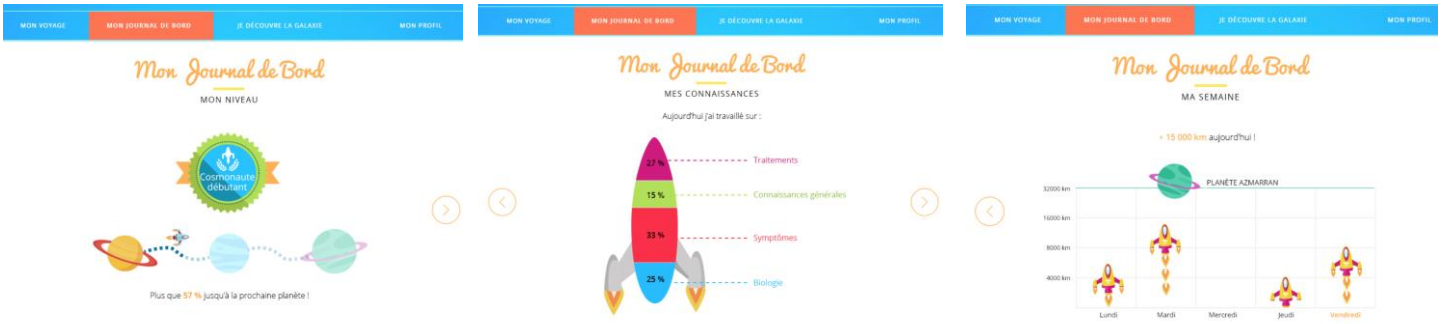

Fig.2: Visualization of what the child does on KidBreath (left : level reached; center : subjects seen today; right : time spent this week)

Because more the system is easy to use, more the objective will be reached with efficacy, efficiency and satisfaction (ISO 9241-11), we first checked the ergonomic criteria of Bastien&Scapin(Bastien & Scapin, 1993)and then we plan to evaluate *KidBreath*'s usability with the System Usability Scale (Brooke et al., 1996).

3.2.Motivation & Knowledge

We add some features to increase asthma kids motivation to continue to make learning activities. To evaluate if the possibility of choosing activities (Fig.3) can maintain motivationand increase learning instead of non-possibility,first we will used the motivation questionnaire made by Cordova &Lepper(Cordova & Lepper, 1996).For the evaluation of knowledge about asthma, we will use a knowledge questionnaire in pre and post-test session (using the same questions encountered in the activities).

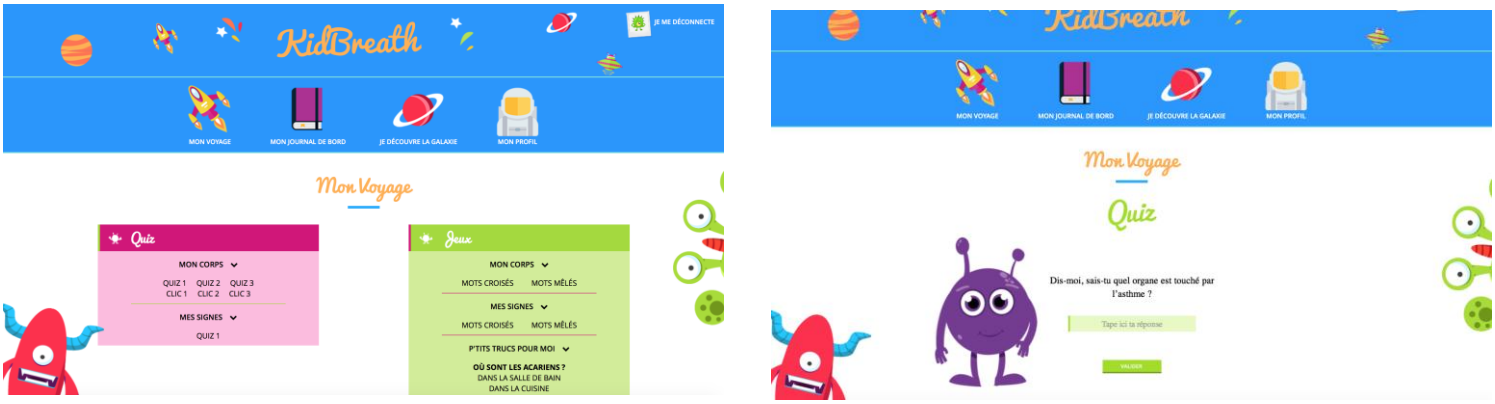

Fig.3: Learning activities interface in "choice" condition (left), and in "no-choice" condition (displayed in random) (right)

4. Results & Discussion

First, we conducted a participative design workshop with forty kids aged 8 in order to iterate over the application interfaces. Then we realized a focus group with 5 asthma kids to validate the global comprehension of a part of the content. It revealed that childrenwanted more contents about the crisis treatment.Finally, we experimented two conditions in 40 control children, one giving the possibility of choosing activities like the child wants, and one no giving this choice (activities displayed in random). Results are in progress, but we hypothesized that*KidBreath* is easy to use, children acquire more knowledge and are more motivated using this system in the choice condition rather than no-choice condition.

5. Conclusion & perspectives

Until now, therapeutic observance was used to define the patientbehavior when he takes his medication as prescribedand adopts healthy behavior. Nowadays, this term is pejoratively used and tends to mean there is bad observant and good observant. It isprogressively replaced by the term therapeutic adherence, which precise that the change of behavior must involvean evolution of the psychological view. This paradigm explains our approach: if we want to change disease awareness and consequently healthy behavior (decrease of accidents by iatrogenic effects), we have to improve factors which influence it: usability (ergonomic approach), knowledge (cognitive approach) and motivation (psychological approach).

In the nextversion, wewill implementan Intelligent Tutorial System composed to learning optimization algorithms. These algorithms, implemented first for theKidLearn Project(Clement, Roy, Oudeyer, & Lopes, 2013), use child success rate and the Zone of Proximal Development(Lopes et al., 2014), which is the "zone" where learning activities are neither too easy (to avoid child boredom), nor too difficult (to avoid abandonment). In this way, the activities proposed fit to each child learning style (memory capacity, initial knowledge, information perceptions).To evaluate if a personalized system improves disease knowledge more efficiently than a generic learning system, we will use the same knowledge questionnaire described above.

Finally we will evaluate the impact of *KidBreath* on perception of asthma with the IllnessPerception Questionnaire adapted to the target population (Broadbent, Petrie, Main, & Weinman, 2006; Chateaux & Spitz, 2006), and the behavior (Parent's observations, treatments dose counting, reduction of doctor's appointment).

Keywords: Adherence, Asthma, Therapeutic Education, Intelligent Tutoring System

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