

## Bonnes pratiques de conception de jeux sérieux pour enfants autistes

### Avant propos

Ce document présente des bonnes pratiques issus de la synthèse de divers articles de recherche.

Ce document servira de base pour alimenter la conception générale du jeu sérieux et pour la conception fine des scènes du jeu.



# Bonnes pratiques générales

Several instructional methods are generally applied for developing skills to children with ASD. Discrete Trial Training (**DTT**) [1] uses sequenced instructions and repeated opportunities with an error-less procedure. It is efficient, effective, and appropriate for teaching many skills that require a great deal of repetitions and are not intrinsically motivating. Over time, DTT procedures have also highlighted the importance of generalization. Naturalistic approaches of instruction seem to generalize more easily and effectively than others: incident teaching, pivotal response training (**PRT**) [20,21], Natural Environment Training (**NET**) [2]. The more appropriate instructional methods for children with ASD (Autism Syndrom Disorders) have to be a combination of these applied behavior analytic procedures. The Applied Behavior Analysis program (**ABA**) [3] is one of them and can be considered as a general framework to also consider for teaching many skills, including the visual skills the project dealt with. ABA consists in the following key-principles:

- **Individual programme:** students must have a programme that matches their strengths and needs.
- **Task analysis:** skills or tasks that need to be taught must have to be analyzed and break down into small tasks.
- **Discrete trial and prompting:** each step have to be taught separately.
- **Reinforcement:** teacher has to plan to reinforce each step with something that is highly motivating for the student.
- **Repetition and prompt fading:** each step have to be practised repeatedly until the student can carry out that component of the skill with no prompting (**scaffolding learning and guidance**).
- **Skill development:** each step must be built systematically until the whole task can be completed independently by the student.
- **Data collection:** data have to be frequently collected in order to monitor the students acquisition of the skill and the effectiveness of the programme.
- **Generalization:** student have to be taught to complete the task in different settings, with different people and at different times.
- **Developmental skill building:** skills have to be developmentally built in order to build a strong foundation that will serve to inspire self initiated life long learning.

ABA stimulates desirable actions by children through structural positive reinforcement [19]. Also, as in many ABA programs, clients with ASD are structurally prompted to perform an action if there is no direct response. With prompting, a child is given extra guidance in a specific way to what he or she should do. (For instance, in a situation where a client needs to ask a question, the trainer can ask: —What can you ask me right now?).

Pivotal Response Training (PRT) in particular is a method of systematically applying the scientific principles of ABA to teach learners with ASD [20,21]. PRT builds on learner **initiative** and **interests**, and is particularly effective for developing communication, language, **play**, and social behaviors. PRT was developed to create a more efficient and effective intervention by enhancing four pivotal learning variables: **motivation**, **responding to multiple cues**, **self-management**, and **self-initiations**. According to theory, these skills are pivotal because they are the foundational skills upon which learners with ASD can make widespread and generalized improvements in many other areas.

In our project context, the targeted mobile app cannot be considered as a naturalistic learning environment as required by the PRT practices. Instead, we will use conjointly techniques from ABA together with principles of PRT for developing our 'escaping scenarios' (as already mixed in other projects [22]).

## Caractéristiques pour concevoir un jeu sérieux pour enfants autistes

Several articles have already reviewed serious games for individuals with ASD. Some are more generally dealing with "computer-based interventions" or "technology-based interventions" including serious game and gamification aspects like [4] investigating the use of Virtual Reality or [5] and [6] about interactive technologies for autism. More precisely relating to serious games [7,8,9,10,11] have reviewed articles focusing on serious games for ASD children in different aspects (technology classification, purposes of the serious game, characteristics of the intervention, effectiveness of interventions) and characteristics of the game developed. These reviews cover together case-studies from 2002 to 2014.

All reviews do not detail their numerous serious game case studies in terms of concrete game-designed elements. Gaming aspects are generally only sketches in terms of global interaction or general game elements from various levels of abstraction: for examples (from [10]) filling (shapes), game level up, multiplayer, collecting or beating objects, constructed shapes, puzzle pictures, and so on. [8] and [9] uses the "10 ingredients of great games" [12] (self-representation with avatars; three-dimensional environments; narrative context; feedback; reputations, ranks, and levels; marketplaces and economies; competition under rules that are explicit and enforced; teams; parallel communication systems that can be easily configured; time pressure) to score reviewed case studies. These 10 criteria covers the 5 levels of game design elements proposed by [13]: they are at different levels of abstraction.

Nevertheless these reviews highlight some good practices, and sometimes propose suggestions or recommendations, for those interested in designing and developing serious games for people with ASD:

1. to take into account **dysfunctional sensory processing** [10] in the activity design;
2. to tap into **children's interests** when possible [7];
3. to allow children to **select their favorite characters** at the beginning of the game from a range of faces that have been drawn as cartoon characters. They tend to play as a game character which is consistent with their real-life identity in terms of gender [10];
4. to have **customization tools** so that parents and teachers can control **visual & auditory feedback**, to avoid negative or repetitive behaviors [10];
5. to include, for in-person instructional supports, a modeling of correct behaviors, corrective feedback from teachers/therapists, and to provide additional **in-person contexts** for practicing learned skills [14];
6. to propose **different types of self-reflection prompts**, tailored in developmentally sensitive ways that directly aid in learning and do not distract from game-play by being too easy, difficult, or abstract [15];
7. to propose a game-method applying **distinct rules** which enable the player to understand and to win the game whilst playing. It is highly useful to indicate **explicit** and **easy-to-understand rules**, and try to only use **one rule at a time**. All this eliminates additional distraction and thus simplifies the use of the game-method for autistic children [8];
8. to present a **score panel of difficulty levels**, so that it is easy for teachers and parents to recognize the children achievements [10];
9. to put a **strong emphasis on the visual design** but take particular care to **not overwhelm** children **with extra visual stimuli** [8];
10. to **contextualize learning** for easing the generalization [7];

11. to include specific **generalization activities for encouraging transfer of knowledge** [11];
12. to have a **shorter duration for focused intervention practices** and invest a **longer period of time for comprehensive treatment** [9];
13. additional ingredients of games may also provide an enhancement through the chosen method, such as the **narrative context** [8] or **marketplace** or
14. , and **feedback** [9];
15. to use **storylines**: story-driven goals (especially when designed to be meaningful to the individual playing the game) can increase affective engagement and are thus critical for providing a rationale for driving game play [11];
16. to focus on the inclusion of long-term goals that are tied to a narrative storyline. The specific storylines and narratives need to be directly **integrated with the educational objectives** to maximize learning potential [11];
17. to promote **communication** between multiple individuals with ASD in cooperative games may provide unique and safe opportunities for them to practice communication and social skills within the game, as well as practice with working collaboratively towards achieving their goals [11];
18. to **pair with other activities** that supplement the game-based instruction and encourage generalization of the material beyond the game [16].

The first six recommendations are about adapting the design to the children's profile whereas the other ones suggest general important design aspects.

Discussion about ASD-specific game designs because of their general- purpose approach, current reviews do not tackle the suggestion of concrete game elements from the perspective of the gamification / serious game domain research. Nevertheless, it appears that not all game ingredients might be suitable for children with autism. For example, children who experience difficulties with collaborative play and social skills might not enjoy playing in teams. Other children can feel uncomfortable when wearing specific equipments. This is likely to be a reason some of the ingredients are rarely used. Therefore, the interventions should not be valued too much based on the used ingredients. The choices made in designing the interventions are rarely well-substantiated. [9] recommended to carry out more research into the **demands of the children** and **designing the interventions in a more user-centered way**.

The intervention training may need to be much more extensive. Serious game principles are designed to this point: they provide learning contexts that are more immersive and contextualized so that learning of difficult behaviors and skills can be scaffolded as motivation to learn them is intrinsically enhanced. As suggested by [11], interventions utilizing computer technology for individuals with autism could be greatly improved upon and will likely produce better results by including more elements of serious game design. According to [14] and [11] blended computer and traditional in-person instruction model in autism interventions could be very efficient. The additional in-person activities may be helpful for providing opportunities for applying the learned knowledge in new settings, or for further reflecting on the learned material.

As mentioned by [11], the **types of instructional supports should be chosen at a developmentally appropriate level** for the individual learner, as individuals with lower meta-cognitive or language abilities may need differing types of instructional supports than individuals with higher meta-cognitive or language abilities.

Applications like the one aimed by the Escape Room project have to be **adapted to children's cognitive level**. Adaptation can be considered at design-time by adapting the application, if targeted children share common cognitive characteristics according to the pedagogical objective, as well as at parameterization-time through the specification of dedicated learning scenarios by therapists. For individuals with higher language abilities, reflection activities to discuss the newly learned material with a teacher or peers could also be utilized as generalization activities [14]. Developmentally appropriate instructional support during therapy sessions may provide important scaffolding for

increasing the generalization of learning from the computer to in-person social and communicative behaviors.

All the recommendations are interesting but research has not yet been conducted to examine what types of instructional supports are most effective for improving learning for individuals with autism, and what personal characteristics (such as language abilities) predict individual differences in the benefits of these supports [11]. The use of well-designed serious game interventions, which is one of the project objectives, for children with ASD may provide opportunities for **cost-effective teaching tools** that can be used at home, in classrooms, or other therapy settings **to supplement traditional teaching methods**.

The majority of computer-based interventions for individuals with autism using cognitive training or virtual reality paradigms do not include many of the key elements of serious game design. We agree with [11] who argues that future research should focus on key issues related to the design of the computer-based interventions. Nevertheless, some general game design principles have been proposed by [17]. Their study was about understanding user needs from the perspectives of both parents of children with ASDs and the children themselves. Their four recommendations overtook the aforementioned discussions:

- to allow **individual customization**: **avatars** and interacting agents, **feedback**, **rewards**, **combination of text / audio / video**, **visual elements** of the game, **context** of the game environment (e.g., home, school, bus stop, or real environment etc.). It is necessary to effectively enable **preferred feedback styles upon childrens characteristics and preferences**.
- to incorporate **context** into the game: being able to understand how certain emotional responses result in a particular outcome should be a primary goal of an intervention tool. By providing context, children with ASDs may be better able to apply the skills learned within the game and generalize that knowledge to real-world situations.
- to **enable adaptability**: the game has to adapt to the behavior of each child. Being able to detect repetitive or negative behaviors, a loss of eye-contact, as well as to dynamically react from children verbal commands, etc. is a significant technical challenge.

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