VRMIND– Virtual Reality Based Evaluation of Mental Disorders
SME2 – Ref: 733901
H2020 – SME Inst – 2016/2017

Start date of project: January 1, 2107
Duration: 24 month

D5.10 – Independent Report on the performance of AQUARIUM on European population

Version:	1.0
Date:	09/03/2019
Dissemination level: (PU, PP, RE, CO):	PU

Project Co-Founded by European Commission within the Horizon 2020

Version:	Edit version
Date:	Edit date

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

VRMIND-AQUARIUM (Nesplora Aquarium from now on) is a neuropsychological test for attention in people from 16 to 90 years old. It is a Continuous Performance Test (CPT) designed to evaluate mainly attentional processes and working memory and support the diagnosis of attention disorders, as well as the assessment of any adult with a clinical condition where attention is impaired. This assessment is carried out through the performance of the person within a virtual aquarium. Therefore, it is also valuable in disorders where attentional processes are essential like different dementias, acquired brain injury, affective and anxiety disorders and multiple sclerosis, among others. Nesplora Aquarium offers scores about: sustained attention, selective attention; working memory, inhibitory control; processing speed and its deviation, switching capacity and perseveration. Both visual and auditory stimuli are presented, so that both sensory channels are working at the same time.

This product was launched to the market on 2018 and from the development of the tool up to now both the professionals from Nesplora and also our customers have made different studies with this tool and we continue researching with Nesplora Aquarium since these studies increase the visibility of the tool and its clinical value.

This deliverable describes in section 3 the contacts with potentials collaborators made and the studies which were finally carried out, while the main conclusions are drawn up in section 4.

It is important to notice that our current collaborators in Europe have not shared with us all the data and they will do it in the future. Besides, we are currently talking and trying to reach agreements with other potential collaborators in Europe to take advantage of the collaborations than can be stablished in the last months of the project.

2. RELATION WITH OTHER WPS AND DELIVERABLES

This deliverable is closely related with D5.11 (Independent report on the performance of AQUARIUM on Latam population) and D5.12 (Independent report on the performance of AQUARIUM on N. American population).

3. COLLABORATOR'S STUDIES

Since the moment the tool Nesplora Aquarium was developed and ready for its use in the research field, we started looking for European collaborators. First of all, we contacted with those members who signed an interest letter to collaborate with us and also with our current clients who were already using Nesplora Aula but also have access to adult population and that have previously expressed interest in carrying out studies with Nesplora Aquarium. Most of our contacts did not want to collaborate with us mainly due to agenda constraints and difficulties to achieve the ethical issues.

So we started inviting different experts in the neuropsychological field. These unsuccessful contacts are shown in table 1.

We also published a profile in the Enterprise Europe Network - EEN. And finally we managed to have the collaborators described in the following sections. We have talked with all of them and they are in different phases of the collaboration process. Most of them have already finished the study, while other are still recruiting sample or carrying out the study itself.

3.1 SPAIN

3.1.1 ADAHIgi

Collaborator's description:

ADAHIgi is a non-profit association, whose objective is to publicize, help, advice and train families and professionals in Attention-Deficit Hyperactivity Disorder (ADHD), in order to improve the quality of life of those affected and increase their chances of success in everyday life. The Association of Attention Deficit Hyperactivity Disorder of Guipuzcoa (ADAHIgi) was born in 2002 from the initiative of parents and professionals once the problems of these children have been studied at family, school and social level.

Location: San Sebastian

Sample: 26 participants over the age of 16 with ADHD.

Sociodemographic data:

We received the data of 26 subjects, who range from the age of 16 to 58 years old. 15 of them are male and 11 female.

The diagnostics of the participants were Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD).

Measurements:

- Nesplora Aquarium: Nesplora Aquarium (Climent, 2018) is a continuous performance test that takes place in a virtual scenario, very similar to a real aquarium. During 20 minutes, the person is situated in a virtual context, shown through a head-mounted display with movement sensors and earphones and a single-button switch. Perspective places the person in one seat of the mail hall, facing the principal fish tank, where the stimuli appear. Stimuli are presented both on a visual and auditory basis, and, at the same time, previously randomized distractors of ecological nature appear progressively. The core of Nesplora Aquarium is composed by two main exercises: (a) a Dual Xno paradigm-based exercise (i.e., "Press the button with every stimuli EXCEPT when you see the clownfish or you hear the word surgeon"") and (b) a Dual Xno paradigm-based exercise with interference (i.e., "Press the button with every stimuli EXCEPT when you see the surgeon or you hear the word clown").

Objective of the study:

The aim of this study is to know the attentional profile of young adults and adults with ADHD through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

On the other hand, the aim is also to analyse the capacity of Nesplora Aquarium to discriminate between people with ADHD and without ADHD.

Hypothesis:

Nesplora Aquarium will be able to characterize the performance and thus, the attentional profile of young and adult people with ADHD. In fact, we expect the clinical group to obtain worse results in the main indices of the test.

Results and conclusions:

At this moment, we have already finished collecting sample with this collaborator. However, we have thought that it would be better to gather this sample to the ones obtained from other collaborators (Dr. Camacho, Vall d'Hebron & INANP), so that the results obtained from the analyses will be more significant and reliable.

Thus, we are waiting to gather the whole ADHD sample from other collaborator and after analysing it the results will be published in an open source journal or presented in a congress.

3.1.2 Hospital Vall d'Hebron

Collaborator's description:

It is a public health center administered by the Catalan Health Institute. It is currently the most important hospital complex in Catalonia, and a private study conducted in 2009, places it as one of the four major hospitals of national reference in Spain and one of the twenty best, including public and private throughout the country.

In particular, the collaboration is being carried out with the department of Psychiatry, which is headed by the doctor Josep Antoni Ramos Quiroga. In this department, they have wide access to patients with ADHD and that start a pharmacological treatment.

Location: Barcelona

Sample: 50 young adults over the age of 16 with ADHD.

Regarding the diagnosis, all the participants will be diagnosed of ADHD as indicated in the study protocol shared with them.

They will be administered Nesplora Aquarium twice, without pharmacological treatment and under it (methylphenidate).

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:
On the one hand, to analyse the validity of the neuropsychological test Nesplora Aquarium for the monitoring of pharmacological treatment in patients with ADHD. As a secondary objective, we aim to quantify and characterize the effect of the administered drug. To do this, Nesplora Aquarium will be applied before and after having started the pharmacological treatment.

Besides, we want to know the attentional profile of young adults and adults with ADHD through their performance in Nesplora Aquarium.

Hypotheses:

- Nesplora Aquarium will be a valid test for the monitoring of pharmacological treatment in ADHD patients.
- Pharmacological treatment has quantitative and qualitative effects on the attentional processes impaired in these subjects, making them improve.
- The clinical group in the pre-test will obtain worse results in the main indices of the test.

Results and conclusions:

As this is a test-retest study, it takes longer time to finish the study. Therefore, we are still collecting the whole data. Once this process is finished, we expect to carry out the analyses and to publish the results in a congress or an open source journal.

3.1.3. Hermanas Hospitalarias

Collaborator's description:
It is a catholic religious congregation, founded with the purpose of attending to the sick, above all, in psychiatric care, mental health and intellectual disability. They have a wide network of resources and hospitals, so that they have access to clinical population in which we are interested for the clinical studies.

Location: Martorell, San Boi, Hospitalet and Barcelona.

Sample: 99 participants over the age of 16 with diagnose of anxiety or depression.

Sociodemographic data:

	Number	Age average	Average education level
Male	24	40.7	Secondary
Female	75	40.8	Secondary
Total	99	40.76	Secondary

	Anxiety	Depression
Male	14	10
Female	49	26
TOTAL	63	36

Measurements:

- Nesplora Aquarium: presented previously.

- STAI: This scale (Buela, Guillé & Seisdedos, 2011) has two verifications, "state" and "trait". We have opted for the "state", to measure the level of anxiety at the time of the evaluation with Nesplora Aquarium. Anxiety as a state: evaluates a transient emotional state, characterized by subjective feelings, consciously perceived, attention and apprehension and hyperactivity of the autonomic nervous system. It is an autoscale that consists of 20 items that are answered by a Likert scale.

- BDI: This test (Beck, Steer & Brown, 1996) is a self-administered questionnaire consisting of 21 multiple-choice questions. It is one of the most commonly used instruments to measure the severity of a depression. It is composed of items related to depressive symptoms, such as despair and irritability, cognitions such as guilt or feelings such as being punished, as well as physical symptoms related to depression (for example, fatigue, weight loss and sexual appetite). The BDI is widely used as a tool for evaluating depression by health professionals and researchers in various areas.

Objective of the study:

The aim of this study is to know the attentional profile of adults with depression or anxiety disorder through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypothesis:

- Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium both between anxiety and depression groups and between clinical and non-clinical groups.

- Clinical groups will show a worse performance on Nesplora Aquarium in comparison with healthy subjects.

Results and conclusions:

We aim to merge the Hermanas Hospitalarias' sample with the samples of (Universidad Complutense de Madrid, BBU & FAEMA) in order to get a big sample that will allow us to reach to more strong conclusions.

However, we have carried out some preliminary analysis with the data of Hermanas Hospitalarias and the results are the following. AS it can be seen in these results, Nesplora Aquarium is a useful tool to characterize the cognitive profile in anxiety and depression pathologies.

ANXIETY STUDY:

- Descriptive data:

	Number	Age average
Male	14	37.9
Female	49	35.3
Total	63	35.9

- Results:

VARIABLES	Significance of Mann-Whitney U test	Result
Omissions	.006	Differences
Visual Omissions	.002	Differences
Auditory Omissions	.017	Differences
Commissions	.856	No differences
Visual Commissions	.865	No differences
Auditory Commissions	.874	No differences
Reaction Time	.392	No differences
Visual Reaction Time	.485	No differences
Auditory Reaction Time	.255	No differences
Task 1 Reaction Time	.208	No differences
Task 2 Reaction Time	731	No differences

Reaction Time SD	.777	No differences

DEPRESSION STUDY:

- Descriptive data:

	Number	Age average
Male	10	44.9
Female	26	50.8
Total	36	49.1

- Results:

VARIABLES	Significance of Mann-Whitney U test	Result
Omissions	.036	Differences
Visual Omissions	.012	Differences
Auditory Omissions	.088	No differences
Commissions	.991	No differences
Visual Commissions	.681	No differences
Auditory Commissions	.803	No differences
Reaction Time	.131	No differences
Visual Reaction Time	.016	Differences
Auditory Reaction Time	.311	No differences
Task 1 Reaction Time	.022	Differences
Task 2 Reaction Time	.180	No differences
Reaction Time SD	.272	No differences

3.1.4. UAB Universitat Autònoma de Barcelona

Collaborator's description:
UAB is the Autonomus University of Barcelona, and it is a public university in Spain, created in 1968. It has 37,166 students and 3,262 teachers and is one of

the most outstanding universities in the Spanish university scene according to the majority of Spanish academic university classifications.

In particular, our collaboration has been established with the Faculty of Psychology, where they help us to collect sample for clinical studies too.

Location: Barcelona.

Sample: 50 participants over the age of 16.

Sociodemographic data:

	Number	Age average	Average educational level
Male	5	24.2 (SD:5.4)	University degree
Female	29	20.2 (SD:2.1)	University degree
Total	34	20.8 (SD:3.1)	University degree

Measurements:

- Nesplora Aquarium: presented previously.

- TP-R. Toulouse-Piéron: This test (Toulouse & Piéron, 2013) allows assessing the perceptive and attentional skills of adults. Specifically, it allows assessing the capacity for sustained attention, concentration, speed and perceptive acuity, as well as resistance to fatigue. Composed of a sheet of graphic elements, it consists of identifying which figures are equal to two given models. Its application can be individual or collective and lasts 10 minutes.

Objective of the study:

The aim of this study is to analyse the convergent validity between Nesplora Aquarium and TP-R and to probe that this second traditional test can be substituted by Nesplora Aquarium.

Hypotheses:

Nesplora Aquarium will show convergent validity with at least some of the main indices of the TP-R.

Results and conclusions:

We aim to merge the UAB's sample with the samples of (Universidad de Oviedo & Nesplora) in order to get a bigger one that will allow us to reach to more strong conclusions. Besides, in Nesplora we carry out our own evaluations in our clinic with researching purposes, so part of this sample can be merged with these samples as well.

Then, the results are expected to be published in an open source journal or congress.

3.1.5. Dr. José Camacho Conde Psychology Clinic

Collaborator's description:

It is an assessment, diagnosis and psychological intervention office that integrates the assistance of all the evolutionary stages (childhood, adolescence, adulthood and old age) from a cognitive-behavioral orientation. Various mental health problems are dealt with, such as depression, anxiety, obsessive-compulsive disorders, etc. They also work on Attention Deficit Hyperactivity Disorder (ADHD) as well as on other developmental disorders.

Location: Málaga.

Sample: A total of 100 participants over the age of 16 with ADHD.

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of young adults and adults with ADHD through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

On the other hand, the aim is also to analyse the capacity of Nesplora Aquarium to discriminate between people with ADHD and without ADHD.

Hypothesis:

Nesplora Aquarium will be able to characterize the performance and thus, the attentional profile of young and adult people with ADHD. In fact, we expect the clinical group to obtain worse results in the main indices of the test.

Results and conclusions:

At this moment, this collaborator has shared with us data from 10 patients. However, we have thought that it would be better to gather Dr. Camacho's sample with the ones of ADAHIgi, Vall d'Hebron & INANP, so that the results obtained from the analyses will be more significant and reliable. Besides, in Nesplora we carry out our own evaluations in our clinic with researching purposes, so part of this sample can be merged with these samples. In this way, we can assure that we get a better and more representative sample for the study.

Thus, we are waiting to gather the whole ADHD sample and after analysing it, the results will be published in an open source journal or presented in a congress.

3.1.6. INPAULA

Collaborator's description:

InPaula is an institute of children neurorehabilitation which emerged in June 2010 with the aim of becoming a referent in innovation and quality, able to offer a cognitive, sensorial and motor integral re-education. But it is, above all, the project of two parents – university professors in Psychobiology and Experimental Psychology – who wanted to offer the best neurorehabilitation system to their daughter, Paula. The multidisciplinary vocation results in a professional team of neuropsychologists, speech-therapists, physiotherapists and occupational therapists that work coordinated on individualized therapies designed for each child, taking always into account the essential labour of its family and closest environment.

Location: Almería.

Sample: 50 people between the age of 13 and 16.

Sociodemographic data:

Up to now this collaborator has shared with us data from 37 subjects. The sociodemographic data of this sample can be found in Section 3.2 of the updated D5.1.

Measurements:

- Nesplora Aquarium: presented previously.
- Nesplora Aula: Nesplora Aula (Climent y Banterla, 2011) is a continuous performance test that takes place in a virtual scenario, very similar to a real classroom. During 20 minutes, the person is situated in a virtual context, shown through a head-mounted display with movement sensors and earphones and a single-button switch. The perspective places the person in a desk, facing the blackboard, which is where the visual stimuli are presented. Stimuli are presented both on a visual and auditory basis, and, at the same time, previously randomized distractors of ecological nature appear progressively. The core of Nesplora Aula is composed by two main exercises: (a) an Xno paradigm-based exercise (i.e., "Press the button with every stimuli EXCEPT when you see an apple or you hear the word apple"") and (b) an X paradigm-based exercise (i.e., "Press the button with every stimuli EXCEPT when you see the number 7 or when you hear the word seven").

Objective of the study:

The aim of the study is to compare the usefulness of Nesplora Aula and Nesplora Aquarium in the age range of 13 to 16 years.

Hypotheses:

Nesplora Aquarium can be a suitable tool to apply to people between 13 and 16 years old.

Results and conclusions:

InPaula is currently increasing the sample for this study. Once it is finished, we will analyze through correlation analysis and mean differences which of the two tests (Nesplora Aula or Nesplora Aquarium) is the one that best discriminates attention problems in children between 13 and 16 years old with ADHD.

3.1.7. UAL Universidad de Almería

Collaborator's description:

UAL, the University of Almeria, is the public university of the province of Almeria and was founded in 1993. They offer university studies of different fields, and within the health sciences, we find the degree of psychology. It is with this faculty that we currently collaborate with.
Location: Almería

Sample: 44 adults over the age of 16.

Sociodemographic data received by the moment:

- Convergent study with Conners CPT 3:

	Number	Age average	Average educational level
Male	5	27.8	University Degree
Female	16	21.7	University Degree
Total	21	23.2	University Degree

- Test-retest study:

	Number	Age average
Male	16	21.7 (SD:0.8)
Female	28	24.3 (SD:9.7)
Total	44	23.4 (SD:7.8)

Measurements:

- Nesplora Aquarium: presented previously.
- Conners CPT 3 (Conners, 2014): The Conners Continuous Performance Test Third Edition is a computerized test that measures attention-related problems in individuals aged eight years and older. It evaluates inattentiveness, impulsivity, sustained attention, and vigilance. The Conners CPT 3 provides information about an individual's performance in attention tasks, complementing information obtained from rating scales such as the Conners 3.

Objective of the study:

The collaboration with the UAL led us to two different studies, each one with its own objective.

The aim of the first study is to analyse the convergent validity between Nesplora Aquarium and Conners CPT 3 and to probe that this second traditional test can be substituted by Nesplora Aquarium.

The aim of the other study is to carry out a test-retest study with Nesplora Aquarium to analyse if there is any existing learning process of the tasks with a margin of two weeks between evaluations.

Hypotheses:

- Nesplora Aquarium will show convergent validity with at least some of the main indices of the Conners CPT 3.
- There won't be a significant improvement on the performance of Nesplora Aquarium in the second administration of the test after two weeks of the first one.

Results and conclusions:

The data show the descriptive values for the Nesplora Aquarium instrument at the two moments of its administration for the sample of university students from the University of Almeria (UAL). All participants took part in both tests, with a delay of one week between each administration,

In order to check whether there are differences between the two moments of instrument administration, and thus ensure its reliability, a statistical analysis was carried out using the non-parametric Mann-Whitney U test, for two independent samples, in which the means of the results of these two moments of instrument administration are compared. We see that the null hypothesis is fulfilled that there are no differences in the two averages of the two groups. Between the test run ratings at the two times of administration, there is no significant difference at a probability of error level less than 0.05 for most variables. We only found significant differences in four of them: S3_perserrors_n; XnoDUALba_auditory_omission_n; S_commission_n ; and T_commission_n.

- In the variable "S3_perserrors_n", the score at the first moment of administration (M= 13.50) was higher than at the second moment of administration (M= 9), this difference being statistically significant U= 327, p< 0.05 and with a Moderate effect size (r=0.351).

- In the variable "XnoDUALba_auditory_omission_n", the score at the first moment of administration (M=2.5) was higher than at the second moment of administration (M=1.5), this difference being statistically significant U=325.5, $p < 0.05$ and with a Moderate effect size (r=0.345).

- In the variable "S_commission_n", the score at the first moment of administration (M=14.5) was higher than at the second moment of administration (M=10), this difference being statistically significant U= 333 $p < 0.05$ and with a Moderate effect size (r=0.376).

- In the variable "T_commission_n", the score at the first moment of administration (M=15.5) was higher than at the second moment of administration (M=10.5), this difference being statistically significant U= 328 $p < 0.05$ and with a Moderate effect size (r=0.355).

Since no differences were found between the means of the two administration moments, this informs us of the reliability of the instrument, in the sense that if the instrument is repeatedly applied to the same subject, it produces the same results. In addition, it informs that there is no learning process in the participants for the tests that complete the instrument.

3.1.8 UCM Universidad Complutense de Madrid

Collaborator's description:
The UCM is the oldest public university in Madrid, considered one of the most prestigious universities in Spain and the Spanish-speaking world. In addition, it is currently the 3rd largest face-to-face teaching university in Europe.
In particular, our collaboration has been established with the Faculty of Psychology, where they help us to collect sample for clinical studies too.

Location: Madrid.

Sample: 104 participants over the age of 16 with anxiety or depression disorders.

	Depression	Depression control	Anxiety	Anxiety control
Valid	36	36	63	63

Missing	0	0	0	0
Mean	49.17	48.97	35.95	37.19
Std. Deviation	12.14	12.09	11.10	10.55
Mann-Whitney U	W=627.5; p=0.822		W=2123; p=0.500	
Minimum	23	23	18	18
Maximum	69	69	58	58
%female	72.22	72.22	92.5	92.5

Measurements:

- Nesplora Aquarium: presented previously.
- STAI: presented previously.
- BDI: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of adults with depression or anxiety disorder through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

- Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium both between anxiety and depression groups and between clinical and non-clinical groups.
- Clinical groups will show a worse performance on Nesplora Aquarium in comparison with healthy subjects.

Results and conclusions:

The results obtained in this study show attentional deficits of both clinical populations when performing a continuous execution test with dual execution components that involve the participation of the central executive system of the working memory.

In the case of the group with affective disorders, a worse performance is observed in those scores related to the attentional arousal during the test. Different studies show difficulties in the updating of the working memory and in the disengagement of the attentional focus in information not relevant related to ruminative thought in these patients. In addition, in this clinical sample, significant deficits are observed in the speed of processing of stimuli, which would be related to the slowdown described both at clinical level and in laboratory tests in these patients.

As for the group with anxiety disorders, our results describe only deficits in the scores related to attentional arousal or surveillance. Although attentional deficits in bias or hypervigilance disorders, our results show that these patients have difficulties in maintaining an adequate attentional tone during the dual execution tasks performed.

These results show that it is possible to use complex neuropsychological tests in virtual reality to identify and describe the cognitive deficits that anxiety-depressive symptomatology produces in these patients.

These results are not without limitations. Beyond the fact that the size of the clinical samples is small, it should be noted that there is heterogeneity within them, may bias the results and that it would be convenient to filter by diagnostics once there is enough sample for it. In addition, for the present analysis, the severity of the symptoms collected by means of the BDI and STAI questionnaires, respectively, has not been used to filter the evaluated sample.

3.1.9 Universidad de Oviedo

Collaborator's description:
This public university was founded in 1608 and currently has more than 25500 students distributed by 17 different faculties that study different academic fields. In particular, our collaboration has been established with the Faculty of Psychology, where they help us to collect sample for clinical studies too.

Location: Oviedo.

Sample: 10 healthy participants over the age of 16.

Measurements:

- Nesplora Aquarium: presented previously.
- TP-R. Toulouse-Piéron: presented previously.

Objective of the study:

The aim of this study is to analyse the convergent validity between Nesplora Aquarium and TP-R and to probe that this second traditional test can be substituted by Nesplora Aquarium.

Hypotheses:

Nesplora Aquarium will show convergent validity with at least some of the main indices of the TP-R.

Results and conclusions:

We aim to merge the Universidad de Oviedo's sample with the samples of (UAB & Nesplora) in order to get a bigger one that will allow us to reach to more strong conclusions. Besides, in Nesplora we carry out our own evaluations in our clinic with researching purposes, so part of this sample can be merged with these samples as well.

Then, the results are expected to be published in an open source journal or congress.

3.1.10 UCM Universidad Católica de Murcia

Collaborator's description:
This private university was founded in 1996 and currently has around 14000 students. It offers 24 official undergraduate degrees and 31 official postgraduate degrees. In particular, our collaboration has been established with the Faculty of Psychology, where they help us to collect sample for clinical studies too.

Location: Murcia.

Sample: 50 participants over the age of 16.

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:

The objective is to analyze the effect of the use of the mobile phone on cognitive performance, which is going to be assessed through Nesplora Aquarium.

Hypotheses:

Nesplora Aquarium will show a worse cognitive performance in those where the use of the mobile phone has a negative effect.

Results and conclusions:

The collaborator is still carrying out the study and by now, we have received the data of 18 participants. Nevertheless, we expect to receive the rest in the following weeks.

Then, the results are expected to be published in an open source journal or congress.

3.1.11 INANP

Collaborator's description:

The Andalusian Institute of Pediatric Neurology offers integral attention to pediatrics and pediatric neurology and at a personal and family level, so they have direct access to young people with neurodevelopmental disorders. They work both in neuropsychological evaluation and rehabilitation.

Location: Sevilla.

Sample: 50 subjects with ADHD over the age of 16.

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of young adults and adults with ADHD through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

On the other hand, the aim is also to analyse the capacity of Nesplora Aquarium to discriminate between people with ADHD and without ADHD.

Hypotheses:

Nesplora Aquarium will be able to characterize the performance and thus, the attentional profile of young and adult people with ADHD. In fact, we expect the clinical group to obtain worse results in the main indices of the test.

Results and conclusions:

At this moment, the collaborator is collecting sample. However, we have thought that it would be better to gather this sample to the ones obtained from other collaborators (ADAHIgi, Dr. Camacho & Vall d'Hebron), so that the results obtained from the analyses will be more significant and reliable.

Thus, we are waiting to gather the whole ADHD sample from other collaborators and after analysing it, the results will be published in an open source journal or presented in a congress.

3.1.12 ADEMGI Asociación de Esclerosis Múltiple de Gipuzkoa

Collaborator's description:
ADEMGI is the Association of Multiple Sclerosis of Gipuzkoa, and plays a role of great importance both for the patients themselves and for their respective families. The fundamental objective of the rehabilitation center with which we have collaborated is to contribute to improving the quality of life of people suffering from Multiple Sclerosis, helping the patient to recover the maximum possible level of functionality and independence, both in physical aspect and in the psychological, social and work aspects.
This collaboration has allowed us to easily access to a sample that would be difficult to get in other way.

Location: San Sebastian.

Sample: 35 participants over the age of 16 with diagnose of Multiple Sclerosis.

Sociodemographic data:

	Number	Age average	Average education level
Male	9	52.6 (SD:12.5)	Primary
Female	29	51.3 (SD:14.1)	Primary
Total	36	51.6 (SD:13.6)	Primary

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of people with Multiple Esclerosis through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium between the clinic and non-clinic groups. In fact, the clinical group will show a worse performance in the main indexes of the test.

Results and conclusions:

At this moment, we have already carried out some analysis. We present above the first results obtained, but we have to make further analysis and focus on the rest of variables that Nesplora Aquarium provides.

VARIABLES	Significance of Mann-Whitney U test	Result
Total Correct	.046	Differences
Task 1 Correct	.017	Differences
Task 2 Correct	.156	No differences
Omissions	.110	No differences
Commissions	.129	No differences
Reaction Time	.727	No differences
Reaction Time SD	.417	No differences
Commission RT	.019	Differences
Working Memory	.046	Differences

In these first analyzes, significant differences have been found between the performance of our group with multiple sclerosis and the control group obtained from our normative sample of Nesplora Aquarium in the following variables: Total number of correct answers and correct answers of the task 1,

reaction time of commission errors and working memory. However, we intend to expand this sample in the future and take into account in the next analysis: the years passed since the diagnosis and the subtype of Multiple Esclerosis. We believe that in this way, and also analyzing other variables offered by the test, we can find a different attentional profile in this population.

3.1.13 AGIFES. Guipuzcoa Association of Relatives and Persons with Mental Illness

Collaborator's description:

AGIFES is a non-profit organization that emerged in 1985 with the aim of achieving normalization and integration in the community of people with mental illness, claim quality services (social, labor, health) and promote the quality of life of the people with mental illness and their families. They develop their activity in Gipuzkoa by managing personalized programs and specialized centers whose purpose is the recovery of people with mental illness.

This collaboration has allowed us to easily access to a sample that would be difficult to get in other way.

Location: San Sebastian and Eibar.

Sample: 29 participants with diagnose of Schizophrenia.

Sociodemographic data

	Number	Age average	Average education level
Male	21	50 (SD:6.7)	Middle Grade Vocational Training
Female	8	47.8 (SD:10)	Primary
Total	29	49.4 (SD:7.6)	Middle Grade Vocational Training

Measurements:

- Nesplora Aquarium: presented previously.
- STAI: presented previously.
- PANSS, The Positive and Negative Syndrome Scale: it is a medical scale used for measuring symptom severity of patients with schizophrenia. It was published in 1987 by Stanley Kay, Lewis Opler, and Abraham Fiszbein. The name refers to the two types of symptoms in

schizophrenia, as defined by the American Psychiatric Association: positive symptoms, which refer to an excess or distortion of normal functions (e.g., hallucinations and delusions), and negative symptoms, which represent a diminution or loss of normal functions. The PANSS is a relatively brief interview, requiring 45 to 50 minutes to administer. The interviewer must be trained to a standardized level of reliability.

Objective of the study:

The aim of this study is to know the attentional profile of people with Schizophrenia through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium between the clinic and non-clinic groups. In fact, the clinical group will show a worse performance in the main indices of the test.

Results and conclusions:
At this moment, we have just merged AGIFES' sample with the sample of FAEMA (explained bellow). In total we have a sample of 46 people. However, we have already carried out some preliminary and the first results are shown in FAEMA's section.

3.1.14 FAEMA Salud Mental

Collaborator's description:
FAEMA Association was created on October 25, 1996, with great effort on the part of families, with the aim of facilitating and promoting the insertion and rehabilitation of people with disabilities due to mental illness. Until now, it has been a more socio-community resource, with the aim of serving family members and people with disabilities due to mental illness. But from this moment it also aims to create employment for people with disabilities.

Location: Ávila.

Sample: 30 participants over the age of 16 with diagnose of schizophrenia, anxiety, depression, OCD (obsessive compulsive disorder) or bipolar disorder.

Sociodemographic data

	Number	Age average
Male	8	47.4 (SD:9.2)
Female	21	49.8 (SD:7.2)
Total	29	48 (SD:8.8)

Measurements:

- Nesplora Aquarium: presented previously.
- STAI: presented previously.
- PANSS, The Positive and Negative Syndrome Scale: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of people with Schizophrenia, anxiety and depression disorders through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium between the clinical and non-clinical groups. In fact, the clinical groups will show a worse performance in the main indexes of the test.

Results and conclusions:

At this moment, we have just merged FAEMA's schizophrenia sample with the sample of AGIFES.

SCHIZOPHRENIA STUDY:

- Descriptive data:

	Number	Age average
Male	38	48
Female	9	48.9
Total	47	48.7

We have carried out the preliminary statistical analysis and the results are the following:

VARIABLES	Significance of Mann-Whitney U test	Result
Omissions	.000	Differences
Visual Omissions	.000	Differences
Auditory Omissions	.000	Differences
Commissions	.188	No differences
Visual Commissions	.153	No differences
Auditory Commissions	.600	No differences
Reaction Time	.620	No differences
Visual Reaction Time	.403	No differences
Auditory Reaction Time	.547	No differences
Commission RT	.783	No differences
Working memory	.000	Differences

These first results show that statistically significant differences can be observed in omission errors and working memory.

On the other hand, we also obtained small samples of participants with depression and anxiety disorders. Nevertheless, we need to gather them with the rest of samples which involve the same type of subjects and carry out further analyses. In the following tables sociodemographic of these small samples are shown.

ANXIETY STUDY:

- Descriptive data:

	Number	Age average
Male	2	42.5
Female	0	-
Total	2	42.5

DEPRESSION STUDY:

- Descriptive data:

	Number	Age average
Male	0	-
Female	4	53
Total	4	53

Obsessive Compulsive Disorders (OCD) STUDY:

- Descriptive data:

	Number	Age
Male	0	-
Female	1	53

BIPOLAR STUDY:

- Descriptive data:

	Number	Age average
Male	3	45.6
Female	0	-
Total	3	45.6

3.1.15 Aita Menni Brain Injury Day Center

Collaborator's description:

The Menni Brain Injury Network in the Basque Country belongs to the aforementioned Hermanas Hospitalarias organization. In this case, they are dedicated to the neurorehabilitation of patients with brain damage, and they have both day centers and hospitalization centers.

This collaboration has allowed us to easily access to a sample that would be difficult to get in other way.

Location: San Sebastian.

Sample: 9 participants with diagnose of Brain Injury.

Measurements:

- Nesplora Aquarium: presented previously.

Objective of the study:

The aim of this study is to analyze the feasibility of administering Nesplora Aquarium in people with Brain Injury.

Hypotheses:

It will be feasible to apply Nesplora Aquarium in this clinical group.

Results and conclusions:

Although the collaboration with this center has concluded, we hope to expand the sample to analyze the data obtained and once this is done, disseminate them.

3.2 ROMANIA

3.2.1 Babes-Bolyai University

Collaborator's description:

The Babes-Bolyai University (UBB - Universitatea Babeş-Bolyai), in Cluj-Napoca, was founded in 1581 and is the largest university in Romania, with more than 51,000 students.
We have the opportunity to collaborate with its Faculty of Psychology to obtain the data for one of our clinical studies.

Location: Cluj-Napoca.

Sample: 50 participants over the age of 16 with anxiety or depression disorder.

Measurements:

- Nesplora Aquarium: presented previously.
- STAI: presented previously.
- BDI: presented previously.

Objective of the study:

The aim of this study is to know the attentional profile of adults with depression or anxiety disorder through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

- Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium both between anxiety and depression groups and between clinical and non-clinical groups.
- Clinical groups will show a worse performance on Nesplora Aquarium in comparison with healthy subjects.

Results and conclusions:

This collaborator is still collecting the data that will be sent to us and that will be merged to the rest of samples which involve the same pathologies, obtained from Hermanas Hospitalarias, Universidad Complutense & FAEMA.

Moreover, professionals of Nesplora have moved to different associations to assess people with these clinic conditions themselves. Therefore, we must merge this sample too. In this way, we can assure that we get a better and more representative sample for the study.

3.3 ANDORRA

3.3.1 SAINE Servei d'Atenció i Intervenció Neuropsicològica

Collaborator's description:

It is a private clinic dedicated mainly to neuropsychological rehabilitation and cognitive stimulation in both children and adults. In this way, they deal with people suffering from neurodevelopmental disorders, brain damage, dementia or intellectual disability, among others.

Location: Santa Coloma.

Sample: 50 adults with multiple esclerosis.

Measurements:

- Nesplora Aquarium: presented previously.
- TP-R. Toulouse-Piéron: presented previously.

Objective of the study:

The aim of this study is double. On the one hand, to carry out a test-retest study with Nesplora Aquarium to analyse if there is any existing learning process of the tasks with a margin of two weeks between evaluations.

On the other hand, to know the attentional profile of adults with multiple sclerosis through their performance in Nesplora Aquarium, in order to provide a better understanding of their cognitive profile.

Hypotheses:

There won't be a significant improvement on the performance of Nesplora Aquarium in the second administration of the test after two weeks of the first one.

Nesplora Aquarium will be able to find differences in the performance of Nesplora Aquarium both between multiple sclerosis group and non-clinical groups. Clinical group will show a worse performance on Nesplora Aquarium in comparison with healthy subjects.

Results and conclusions:

We are waiting to collect all the data to carry out the analysis for the test-retest study and to gather the data to the multiple sclerosis sample we already have.

4. CONCLUSIONS

The aim of these validation clinical studies is to measure the accuracy, validity, sensibility and specificity, for the detection of pathologies, of the Nesplora Aquarium test. From the commercial point of view, these tests are done in order to give value to the test in front of the market so the studies can open new markets in foreign countries.

Nesplora Aquarium has been deployed into the market in 2018 and from that moment until now several studies have been carried out by the R+D department of Nesplora but also by independent experts, mainly our clients.

In spite of the difficulties that often involve finding collaborators to help us develop this type of studies effectively, we are satisfied with the collaborations that we have been able to establish. Up to know the Nesplora Aquarium collaborators have shared with us data from 535 people evaluated which is more than we expected to collect in Europe.

Many of them have not yet been able to send us the data because they are still finishing the evaluations. And when all collaborators share with us the evaluations to which they have committed, we will have data on more than 700 people. We are confident that these professionals will be able to comply with the collaboration agreement and that very soon these studies will be closed. In regards of the potential collaborators that finally did not sign the collaboration agreement, the ethical constraints and the deadline of the studies have been the main reasons to not collaborate with us.

The 17 collaborations carried out or being carried out are very important since they will allow us to publish new scientific articles and to better position Nesplora Aquarium in the market. For instance, the study which is being carried out with ADHD population will help us to demonstrate that Nesplora Aquarium is a valuable tool to assess this collective with attentional problems and to make an objective discrimination between healthy and pathological people. As the Toulouse-Piéron and Conners-3 tests are the golden standard at an international level for the evaluation of attentional processes, when we will finish our current study we will be able to demonstrate that Nesplora Aquarium has good psychometric properties in comparison with these tests.

Of the three regions where we set ourselves the objective of carrying out studies within the VRMIND project, Europe is where we have been able to achieve the best results. This was something to be expected as this is where we are best known and where we have the most clients. Although it is true that with Nesplora Aquarium we have not finally been able to carry out studies in the USA, those carried out in Europe facilitate the entry into future studies in the USA and marketing there, so we can say that we have fulfilled our objective.

In conclusion, these studies, besides providing knowledge to the scientific community, they add value to the Nesplora Aquarium tool, which in turn will boost its commercialization.

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