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Cyber-Neuropsychology: Application of new technologies in neuropsychological evaluation

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Neuropsychological evaluation deals with the study of cerebral functioning through the persons' performance. It makes it possible to collaborate the clinical diagnosis and to provide information on deficit and skills. Specialized care in rural environments is uncommon, and often means impossibility to access some services. This study has aimed to evaluate the possibility of using neuropsychological evaluation by internet videoconferences. Our research was based on the traditional and online application of the SCIP-S to 30 subjects who were diagnosed with schizophrenia. The 30 subjects were randomly divided into two groups (Group A and B). Both groups underwent the two conditions inversely. The results show some differences and similarities when the results in both types of applications SCIP-S are compared. In conclusion, cyber-neuropsychology is possible and may be a complement and alternative to traditional assessment when they cannot develop.

Keywords: Schizophrenia, Videoconference, neuropsychology, Screen for Cognitive Impairment in Psychiatry (SCIP), Cybertherapy and Information technologies and communication

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Ciber-Neuropsicología: Aplicación de nuevas tecnologías en la evaluación neuropsicológica

La evaluación neuropsicológica se encarga de explorar el funcionamiento cerebral a través del rendimiento de las personas. Permite colaborar con el diagnóstico clínico y entregar información sobre déficit y habilidades. La atención especializada en entornos rurales es muy excepcional, lo que muchas veces se traduce en la imposibilidad de acceder a servicios. El objetivo del presente trabajo fue valorar la posibilidad de uso de la evaluación neuropsicológica mediante videoconferencia sustentada en internet. Para ello se aplicó el SCIP-S de forma tradicional y online a 30 sujetos con el diagnóstico de esquizofrenia. Se dividió aleatoriamente a los 30 sujetos en dos grupos (Grupo A y B), ambos grupos pasan por las dos condiciones en forma inversa. Los resultados muestran algunas diferencias y similitudes al comparar los resultados en ambos tipos de aplicaciones del SCIP-S. En conclusión, la ciber-neuropsicología es posible y puede constituir un complemento y alternativa a la valoración tradicional cuando ésta no puede desarrollarse.

Palabras clave: Esquizofrenia, Videoconferencia, Neuropsicología, Screen for Cognitive Impairment in Psychiatry (SCIP), Ciberterapia y Tecnologías de la Información y la Comunicación

INTRODUCTION

Neuropsychological evaluation is used to study cerebral functioning through the persons' performance on tests.[1] Its application in persons with schizophrenia aids the clinical diagnosis and identifies cognitive deficits and capacities/skills presented by this type of patient.[2, 3]

Within neuropsychological research on schizophrenia, one of the most productive areas is related with cognitive deficits. These deficits are a central characteristics as well as one of the principal factors contributing to the functional and social deterioration of these patients.[4, 5]

The Psychiatry Department of Zamora (PDZ) is constituted by a care network that covers the entire Province of Zamora.[6] Zamora can be considered a rural Province because of the distribution of its population into the territory and its low population density. Many users have to travel long distances to satisfy their health needs,[7] and also lack adequate transportation and interconnection system. All the above contributes to the generation of accessibility problems.[8]

Due to the above-mentioned problems, the PDZ has organized itself in order to facilitate access, especially to the rural population. It has initiated an itinerant mental health team to provide support to the rural health centers. This

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attempts to assure access to the population residing in distant population centers in order to eliminate inequalities regarding health.[9, 10]

Another possible intervention aimed at improving accessibility would be incorporating the new Information and Communication Technologies (ICTs) in mental health care. ICTs have been used to aid evaluation or treatment of mental problems[11] and have been demonstrated as useful in the mental health setting in cognitive rehabilitation therapies and in evaluation.[12, 13]

ICTs could be a valid and useful alternative that could generate greater and complementary benefits to the traditional care[12, 14, 15] as well as facilitate access to services.[16, 17] It is in this scenario that Cybertherapy arises as an aid modality, using internet communication as a means.[18] These interventions can include diagnostic, psychotherapy or supervision procedures.[19]

In the field of neuropsychology, one of the first evaluation to use ICTs was the Wechsler intelligence scale in 1969.[20] However, and notwithstanding its use in neuropsychological evaluation and intervention, its use did not become a part of the routine work in spite of the advantages it generated.[21]

However, despite the great importance in the evaluation and rehabilitation process,[4] there are difficulties to introduce the ICTs. Standing out among them are the fear of the professional to be replaced by machines[21] or resistance of the professionals to accept the existence of a therapist-patient link through technology.[22] There would be no grounds for this fear since the ICTs may constitute a complementary tool to facilitate the work of the neuropsychologist.

For these reasons, an attempt is being made in the mental health area of Zamora to implement the new technologies in the care activities. However, resistances to its use make the performance of studies confirming its utility, efficacy and usability necessary. To do so, a study has been proposed to determine the utility of the application of the videoconference in the neuropsychological evaluation of persons with schizophrenia.

The purpose has been to compare the application of a neuropsychological evaluation scale using a traditional method versus its application by videoconference with the use of new technologies. It is aimed to know if the application mode intervenes in the results and if the internet-supported videoconference could be used to carry out the evaluation at a distance in the clinical activity. The study results could facilitate the access to the neuropsychological evaluation.

METHOD

Type of study

An experimental study was conducted in which the type of evaluation was controlled, comparing a traditional versus an online context. A pilot study is presented. This study had a quasiexperimental, descriptive and exploratory design. The aim was to evaluate the possibility of using this methodology with schizophrenic patients who live in the rural setting.

Population: Participants sample and selection procedure

The study was conducted in 30 patients living in a Residence for persons with Severe and Prolonged Mental Disease managed by the INTRAS Foundation in the city of Toro who had been diagnosed of schizophrenia, and any of its forms, according to the ICD-10 criteria. Of the patients, 3 had disorganized schizophrenia (10%), 2 in differentiated schizophrenia (6.7%), 19 paranoid schizophrenia (63.3%) and 6 residual schizophrenia (20%).

Participant selection was made using intentional, nonrandomized and non-probabilistic sampling, eliminating those patients from the study who did not fulfill diagnostic criteria. The sample was made up of 8 women and 22 man, ages ranging from 29 to 59 years, with a mean of 50.03 and standard deviation 5.898.

Evaluation and intervention instruments

Screen for Cognitive Impairment in Psychiatry (SCIP-S): it makes it possible to conduct a rapid evaluation of cognitive function of the psychiatric patient.[23] It includes a subtest of working memory, verbal learning, delayed memory, visuomotor speed and verbal fluency. Its administration takes 10 to 15 minutes. The scale would used in four parallel forms to eliminate the learning factor.[24] Version 1 was be used for the traditional evaluation form and version 2 for the online one. There were no major difficulties for the adaptation to the online context of the SCIP-S test. Equally, the visuomotor tracking task considered the use of paper and pencil. In it, a series of symbols was presented that had to be coded for the presence of different stimuli.

To evaluate the task online, a specific adaptation was made to avoid losing the visuomotor component it contains. Thus, files in SWF format were attached in the videoconference room. The evaluator could present a keyboard image and the visuomotor follow-up task, which would remain fixed on the computer screen of the subject who was being evaluated. In this way, the visuomotor task was performed by using the computer keyboard and not on paper.

Table 1 Cronbach's Alpha Reliability Statistics, in direct scores

	Cronbach's Alpha
Group A	
Online	0.675
Traditional	0.736
Group B	
Online	0.711
Traditional	0.832
Online Group A and B	0.680
Traditional Group A and B	0.777

PsychoED program: web program developed by the INTRAS Foundation that permits psychological care by internet. This program facilitates the possibility of carrying out neuropsychology evaluation because different applications, such as videoconference, chat or the possibility of presenting presentations, among other applications, are available.[25, 26] Together with this platform, the Logmein program is used to remotely control the user's computer in case of need.

Field notebook: a qualitative registry was made of the implementation process and evaluation.

Method and procedure

Two neuropsychological evaluation conditions were proposed: online evaluation (by videoconference) and traditional evaluation (face-to-face physical presence). All the participants in the study were subjected to both conditions inversely to compare the differences and similarities between both ways of evaluating. To avoid the learning bias, two parallel versions of the scale were used in addition to dividing the participants randomly into two groups: group A (online-traditional evaluation condition) and group B (traditional-online evaluation condition).

Evaluations by SCIP-S both in its online and traditional condition were developed by two evaluators in order to not influence the results, an evaluator being blind to the type of evaluation being done (first or second). To eliminate possible biases, a neutral setting without distractors was used.

In the online evaluation, the evaluator remained in Zamora and the subject evaluated in the Residence of Toro, located at 32 Km. In the residential site, there was a person who alerted the patient and invited the patient to come to the site where the computer was to do the evaluation. In the traditional evaluation, the investigator went to the residence site of the participants.

Once the evaluations were applied and corrected, they were exported to the SPSS® v16.0. software where descriptive and inferential statistical analyses were made in order to determine if there were any differences in the neuropsychological evaluation by internet-supported videoconference and the traditional evaluation.

Registry of the qualitative data was done in a field notebook, in which the difficulties prior to the evaluation were noted in order to identify and solve possible incidences.

As data, the direct scores were used that were analyzed by the tests: Cronbach's alpha to measure reliability; descriptive statistics and Pearson's correlation (*r*), interpreted according to the orientations of Cohen.[27-29] After, the analysis of the parametric compliance statistics was performed (Kolmogorv-Smirnov and Levene tests) followed by inferential analysis. After obtaining the results of the suppositions, the Student's T test and Wilcoxon Signed Rank test for related samples were carried out. These results were interpreted, establishing an alpha of 0.05.

RESULTS

Qualitative results

It was observed that the most common faults in the online evaluation were due to computer problems: failures in the connection to the server or audio problems related with the internet connection quality. These problems were solved by performing velocity tests and making the evaluations during the hours of the best connection.

Once these shortcomings were solved, high satisfaction with the quality of the image and the final efficacy to adapt the sound was observed.

Quantitative results of the application of the SCIP-S

Once the SCIP-S results were obtained, the statistical analysis was made. Values observed for Cronbach's α were approximately 0.7, which indicates that they are adequate to assure reliability of the scale,[28] it being observed in general terms that the traditional evaluation has greater reliability than the online one, although a sufficient level of reliability is reached in every case.

In the descriptive results of each subtest applied, differentiating between the online and traditional groups, some differences are observed on the descriptive level in the measurements of word learning, repetition of consonants, verbal fluency, delayed learning, visuomotor tracking and performance time. No important differences were found in the measurements for the total score. In addition, the

Table 2 Descriptive statistics of the SCIP-S scales

	Mean	N	Standard deviation
Word learning			
Online	83.8667	30	13.62486
Traditional	78.7333	30	11.58159
Repetition of consonants			
Online	85.2667	30	15.43157
Traditional	92.4000	30	15.40175
Verbal fluency			
Online	91.4333	30	11.92992
Traditional	89.4000	30	11.54482
Delayed learning			
Online	82.7333	30	14.65919
Traditional	83.0000	30	14.89735
Visuomotor tracking			
Online	81.4333	30	9.28730
Traditional	85.4667	30	12.61563
Total score			
Online	81.6667	30	11.35124
Traditional	81.6667	30	13.37350
Performance time			
Online	19.0333	30	7.62701
Traditional	10.8000	30	1.98963

standard deviation showed very similar scores in the subtest of repetition of consonants, verbal fluency and delayed learning. From this point of view, the results indicate that both applications are homogenous. On the contrary, less homogeneity is observed in performance time, word learning, total score and visuomotor tracking.

The *r* results reflect the grade in which the scores of the versions (online and traditional) and groups (A and B) are associated. With values ranging from 0.48 to 0.8 and following the Cohen orientations, the variables measured indicate an important direct correlation (±0.5=large correlation).

The results of the *t* test for related samples in group A (p=0.287), indicate that there are no significant differences between the online and traditional evaluation for the subtest of repetition of consonants. In group B, the results indicate that there are significant differences in the online and traditional evaluation for the subtest of repetition of consonants (p=0.040). In other words, the results indicate opposite directions.

In regards to statistical power, a potency value is observed of 0.339 (α=0.05), and effect size of 0.46, the latter being a size of medium effect.

The Wilcoxon Signed Rank Test for related samples in group A shows that word learning (p=0.023), visuomotor tracking (p=0.004), and performance time (p=0.001) have significant differences between their applications. In group B, it is seen that performance time (p=0.002) has significant differences between the traditional and online application.

CONCLUSIONS

This study has aimed to evaluate the possibility of using Internet-supported videoconference to be able to make neuropsychological evaluation and in this way to evaluate the possibility of the application of the ICTs in neuropsychology. To do so, the SCIP-S (Screen for Cognitive Impairment in Psychiatry) was applied in two different situations, that is, traditional and online. This scale was chosen based on its comfortableness, briefness, availability and equivalent versions, utility and evaluation at distance, and in the variety of functions evaluated, among other characteristics. In this way, the SCIP-S is a battery that is easily adaptable to be used in a pilot study in order to verify if the online evaluation meets the same objectives as the traditional one.

It should be stated that the online application was possible and that it obtained satisfactory results from the clinical point. These results were also observed in a review on the distant evaluation of patients with schizophrenia.[12] Thus, both the publications as well as the results of this study indicate that the online evaluation may be a useful and efficient alternative and that it facilitates access to services and persons with schizophrenia.

The evaluation was made with 30 patients diagnosed of any form of schizophrenia. The number of patients is a sample as this was used as a first step in the pilot study in order to study the performance of the sample design. It was not aimed to close the subject of neuropsychological evaluation but rather to give an opinion. However, the fact or presenting a small sample size is still a limitation.

Specifically in regards to the SCIP-S, the visuomotor tracking task had to be carried out. The qualitative and quantitative results indicate that the adaptation of this task was satisfactory. Regarding the visuomotor evaluation in online or tele-neuropsychological settings, there are accessories that can be considered, as, for example, *tablet*PC,[30] a portable computer with which it is possible to interact with a touch screen. In this case, its use was not necessary, however in tests with a high visuomotor component, and with greater complexity, a PC tablet may be the alternative to consider.

There is little evidence that persons with psychosis react negatively to the online evaluation experience. On the contrary, there is evidence that some patients feel less anxiety regarding the evaluation during the videoconference.[31]

During the evaluation process, it was detected that there are time zones in which the server has a better connection and therefore it was decided to accommodate the evaluation schedule. Regarding the relation, it is indicated that a wider band provides better quality, associated to greater capacity to evaluate.[32] When the time frame could be chosen to use the best connection and thanks to the psyschoEd resources, the problems of poor images or sound quality were solved, these being a reason for concern in several studies.[33]

Regarding the quantitative results, their reliability is considered acceptable (values ranging from 0.67 to 0.83), suggesting internal consistency of the scale. These results point to its utility in the online context. Other studies have obtained similar results, for example in Pino et al., adequate internal consistency is observed of the scale, with values ranging from 0.65 to 0.72.[34] The same occurs in another study where the participants suffered bipolar disorder, in which the internal consistency obtained had a score of 0.74.[35]

The detailed descriptive statistics of the different applications of SCIP-S show the following for group A (online-traditional procedure): in **word learning** better performance in online evaluation. There is also greater variability of the results. These differences are significant. Said variability may be due to possible sound problems.

Thus, in word learning, we find better performance in the online group, in spite of there being greater difficulties. This result could be because greater concentration is required by the person being evaluated or because some interpersonal variables are eliminated.

In regards to **repetition of consonants,** better performance is observed in the traditional evaluation, this being without effect in the variability. These results are significant in group B (traditional-online procedure). On the contrary, performance is better in the online evaluation and also without effects on the variability in **verbal fluency**. These results are not significant. The same occurs in **delayed learning** where there are no significant differences in performance or variability.

In regards to the **visuomotor motor tracking** test, better performance is observed in the traditional evaluation, however, there is also greater variability. These differences are significant in group B. It is correct to attribute these differences to the time it takes to explain the online modality since it is greater because of the lack of paper support as in the case of the traditional evaluation, that facilitates its explanation. Similarly, these differences can be attributed to scarce familiarity with the keyboard rather than to the difference of the similarity of the task on paper support with any exercise performed in school age.

In the **total score,** similar performance is observed between the two applications. As both types of evaluation have the same performance, this is the most important result since there are no differences between the application of both versions of the SICP-S.

The greatest variability occurs in **performance time**. This is principally affected by the results in the sub-test of visuomotor tracking, where there are greater differences both in performance and in variability. In group A (online-traditional evaluation condition), there is more delay, since it is a new test for the subjects, and coding is difficult.[37] On the contrary, performance time receives better results in the traditional evaluation since the subject listens to the explanation on the performance of the test without sound interferences. In this way, more research needs to be carried out, this being oriented towards the effects of the sound problems in the online neuropsychology evaluation.

In spite of the differences in performance time, it can be concluded that the visuomotor component is maintained in the online evaluation. In this sense, it is important to stress that although there are significant differences in both versions, the test was carried out optimally without losing its important characteristics, that is, without losing the visuomotor component characterizing it.

It should be considered that the online application is performed when there is no possibility of doing it face-to-face due to access problems. Thus, although the online application takes more time to apply, this time is short if the time it would take to go from Toro to Zamora is taken into account as well as the time that it would take to make the traditional evaluation. From this point of view, and considering all the time that an evaluator would take to make the traditional evaluation, including travel, **79%** of the total time used in the traditional evaluation would be saved by the online application.

This savings in time means a decrease in capital cost of the evaluation. In this regards, when Mielonen et al. made a cost analysis of 20 patients per year, they found that the capital cost was lower in a distant evaluation than when a traditional one was made.[36] Thus, conducting an online evaluation is a savings measure in regards to time and capital compared to the conventional methods that involve travel.

Equally, although the online evaluation has worse yield in performance time, this is not important since the cyber-neuropsychology makes it possible to overcome other barriers as rurality and access difficulties.

In the correlation coefficients between online and traditional versions and each one of the groups (A and B), we found coefficients between median and large. This indicates adequate reliability between groups and versions. The same occurred in a comparison of the SCIP psychometrics[24] and other studies that evaluate the psychometric properties of the SCIP.[33] In other words, the results regarding the correlation coefficients in the online application obtained similar results as those concluded by other studies. In this way, the online SCIP-S application obtains adequate reliability.

It is important to note that the SICP-S did not have to be modified to apply it in the online evaluation. The same results were achieved as in the traditional application only by using additional and complementary information. Furthermore, it can be concluded, in the first place, that persons with schizophrenia can be cybernetically evaluated and in the second place, that the SCIP-S can be applied cybernetically.

After having made the pertinent statistical analyses and discussed the results obtained in the performances of the online and traditional evaluations, it can be concluded that the neuropsychological evaluation by internet is possible and reliable, since the differences found in the application time do not prevent the neuropsychological evaluation. In this way, there would be some necessary adjustments, because it takes longer to make the online evaluation, but this does not prevent it from being carried out. Furthermore, this time is compensated with the time it would take to initiate the traditional evaluation regarding movement of means and professionals.

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