

# Towards remote handwriting deficits therapy: a study on the use of a touch-screen in replacing paper

**Mario Conci, Fabio Pianesi,  
Massimo Zancanaro**  
FBK-Irst  
Via Sommarive 18,  
38123, Trento – Italy  
{mconci,pianesi,zancana}@fbk.eu

**Rita Capasso, Alessia Monti,  
Gabriele Miceli**  
CeRiN,  
Via Matteo del Ben 5/a,  
38068, Rovereto (TN) – Italy  
{rita.capasso,alessia.monti,gabriele.miceli}@unitn.it

## ABSTRACT

**Motivation** – This pilot study wants to explore the effect of a touch-screen on the rehabilitation of acquired dysgraphia. The outcomes of the study might be useful for the design of a tele-rehabilitation system for handwriting disorders.

**Research approach** The touch-screen is compared with the more traditional, pencil-and-paper approach. A specific software application was designed, based on a User Centered Design (UCD) approach and involving patients and therapists.

**Findings/Design** – Two patients with moderate aphasia agreed to participate in testing the application. The results showed no negative effects on the treatment and revealed a positive attitude towards the touch-screen from both patients and therapists.

**Take away message** – This preliminary study shows a substantial effectiveness of the touch-screen used as a device in the rehabilitation of handwriting deficits, and brings out issues relevant to the development of a tele-rehabilitation system.

## Keywords

Aphasia, handwriting deficits, tele-rehabilitation, technology acceptance.

## INTRODUCTION

Adult aphasia is an acquired communication disorder that impairs a person's ability to process language [2]. It affects the ability to speak and understand others, and very often also disrupts reading and writing. The most common cause of aphasia is stroke, but head injury, brain tumor or other neurological diseases are also frequent causes of the disorder. In many cases, patients can improve their communication skills through speech therapy, and some of them eventually go back to a normal life. In order to be effective, a rehabilitation program should start as soon as possible, should be intensive and should be carried out during the recovery phase [7]. Intensity and regularity of the intervention are critical for a good outcome, and imply that patients attend the rehabilitation centre on a daily basis. A schedule of this type is very difficult to follow for subjects who cannot autonomously reach the rehabilitation centre, and must rely on relatives' help for transportation – this has serious impact also on the everyday life of the caregiver.

As a consequence, traveling difficulties may make access to rehabilitation impossible for many patients.

ICT can provide opportunities to overcome these problems, granting remote access to therapy and appropriate treatment intensity even from far-away places [2]. From the therapist perspective, remote therapy may also represent an opportunity for improving the efficacy of their job, e.g. they may follow several patients simultaneously, and exploit the technology for better data storage and analysis. Remote therapy is also useful for subjects who have completed the post-acute rehabilitation phase and only need to autonomously practice tasks at homes. A potentially useful technology that has been used in the tele-rehabilitation of aphasic deficits is the touch-screen [see for example 4,6]. Yet, it has been studied mostly for the rehabilitation of speech disorders, and little is known about its usefulness in the case of writing disorders.

In this work we present a pilot study aimed at investigating the effects of introducing a touch-screen device in the context of dysgraphia treatment. The study focuses on the patient's attitude towards the touch-screen, and on its efficacy and benefits for therapy. We will also highlight issues that may be considered in a tele-rehabilitation system.

## THE STUDY

In order to reduce the confounding variables of the remote setting, we designed a simple application for a touch-screen device that reproduces as much as possible a classical pen-and-paper therapy scenario and used it to run our study in a face-to-face setting. Two therapists and two patients participated in the study. Both therapists administered the therapy to both patients. One of the patients was a 55-yr old woman with a mild handwriting deficit, the other was a 40-yr old woman with a moderate dysgraphia. Patients had already participated in therapy sessions for language disorders in the rehabilitation centre.

## Design of the application

The application was designed following a User Centered Design (UCD) process. We approached therapists who contributed their expertise with patients. As a first step, we systematically gathered requirements, by using the method of contextual inquiry [1]: we collected data on the therapeutic context, on the approach used by the

therapist, and on the setup of rehabilitation sessions. From those data a first set of user requirements was extracted. We translated them into system requirements and started an iterative refining process involving the designer, the software engineer and the therapists. The application supported 4 tasks that are typical of the rehabilitation of handwriting deficits (see section 2.3). The basic functionalities of the application were: undo/redo (a specific stroke), change task, previous/next stimulus, repeat stimulus, and flag (for marking particularly interesting responses of the patient). The application was run on a commercial touch-screen. Since patients need a sensitive surface to naturally use as a sheet of paper, we chose a commercial touch-screen specifically designed for drawing, which was very sensitive, easy to move, thin and light.

### Methods

Tasks that are usually performed in handwriting rehabilitation are: *Dictation*: the patient has to write stimuli that are presented auditorily; *Naming*: the patient has to write the name of a pictured object; *Completion*: the patient has to write the missing letter(s) in an incomplete stimulus word; and *Verification*: the patient has to check the spelling of a stimulus word, in order to find misspellings and correct them.

In this pilot study we considered only the dictation task, using words and non-words from the BADA battery [3]. Two treatment blocks were designed for both patients: the first block was administered with the standard procedure (pencil and paper; PP), the second by using the touch-screen and a digital pen (TS). Each treatment block lasted one month. In both cases, stimuli were pre-recorded and presented through the computer loudspeakers. The touch-screen was used like a sheet of paper. It was placed between the patient and the therapist and could be arranged in the most convenient way by the patient. The therapist conducted the therapy session by using the application commands. Every answer from the patient was automatically recorded.

### Data collection

To assess the effect of the touch-screen on treatment outcomes, we analyzed the errors made by the patients at the end of each treatment block, and compared them with the results of a baseline assessment conducted one month before the beginning of the study.

To evaluate the therapist's attitude towards the touch-screen, a questionnaire was administered in the middle and at the end of the TS phase. In the questionnaire therapists had i) to list positive or negative aspects of the touch-screen, ii) to assess their level of satisfaction with the TS, and iii) to provide a personal assessment of the involvement and anxiety of the patients. An interview was administered at the end of the TS phase to the therapists only. During the study, the therapists were asked to write down any comments about the usage of the touch-screen. In order to assess the preference for PP or TS, patients filled a questionnaire at the end of the study (see Table 2).

## RESULTS

The quantitative results from the therapy assessment were compared with baseline, pre-treatment data (see Table 1). They did not show any negative impact on the patients' performance and a relatively regular trend for the patients both in the TS and in the PP phase.

**Table 1. Results from the therapy**  
(% of Errors: Words vs Non-words)

	Patient A		Patient B	
	Words	N-Words	Words	N-Words
Baseline	28.3%	64.5%	4.5%	17.3%
After PP session	29.4%	69.1%	2.8%	13.6%
After TS session	23.4%	66.4%	2.1%	9.1%

From interviews and questionnaires, patients expressed a positive attitude towards the touch-screen even though initially one of them did not feel comfortable with it. More in detail, they evaluated the touch-screen as an appropriate tool for carrying out the rehabilitative program (see Table 2). Therapists reported a high satisfaction and a good attitude towards the touch-screen: it allowed them to manage sessions easily and provided good support in data filing and analysis.

**Table 2. Results of the patient's questionnaire**  
(from 1: Absolutely not to 5: Absolutely yes)

	Pat1	Pat2
TS is tiring for the hand used for writing	1	1
With TS the work field is tidier	5	5
TS allows a more natural writing posture	4	2
It is easier to manage the paretic arm	4	5
TS is appropriate for handwriting therapy	4	3

## CONCLUSION

In this pilot study, we used a commercial touch-screen in an application for handwriting rehabilitation. Our goal was to explore and understand the implications of its use on the rehabilitation process, and to highlight critical areas to take into account in designing a tele-rehabilitation system.

The touch-screen was well accepted by patients and therapists. Therapists were also satisfied with the TS, especially because they felt that it supported them in session management and data storage and analysis. Although based on only two patients, these results are encouraging, as they support the idea that touch-screens can be effectively used in remote rehabilitation systems. Yet, other important issues emerging from reports on sessions should be considered. Firstly, an important relationship is established between therapist and patient, based on informal conversations. Secondly, watching the patient's face and hand is crucial for the therapist in order to understand and assess his/her performance. On the other hand, eye-contact is crucial also for the patient, as it provides emotional support and feedback on performance. In conclusion, in the design of systems for remote rehabilitation, particular attention should be devoted to technology solutions and interaction modalities which contribute to shorten the distance between patient and therapist, and favor the creation of a (virtual) shared space.

## REFERENCES

- [1] Beyer, H., Holtzblatt, K. *Contextual Design*. Morgan Kaufmann Publisher, San Francisco, 1998.
- [2] LaPointe, Leonard L. *Aphasia and related neurogenic language disorders*. New York: Thieme, 2005.
- [3] Miceli, G., Laudanna, A., Capasso, R. *Batteria per l'Analisi dei Deficit Afasici - B.A.D.A. Versione computerizzata*. Bologna: EMS, 2006.
- [4] Moffatt, K., McGrenere, J., Purves, B., and Klawe, M. The Participatory Design of a Sound and Image Enhanced Daily Planner for People with Aphasia. *CHI 2004*, Austria. April 24–29, 2004.
- [5] Pierrakeas, C., Georgopoulos, V.C., Malandraki, G.A. Online Collaboration Environments in Telemedicine Applications of Speech Therapy. In *Proceedings of the 27th Annual International Conference of the Engineering in Medicine and Biology Society, IEEE-EMBS 2005*.
- [6] Theodoros, D., Hill, A., Russell, T., Ward, E., Wootton, R. Assessing acquired language disorders in adults via the Internet. *Telemedicine Journal and E-Health*, 2008, 14(6):552-9.
- [7] Zampolini M., Todeschini E., G., Guitart M-B., Hermens H., Ilsbrouckx S., Macellari V., Magni R., Rogante M., Scattareggia Marchese S., Vollenbroek M., Giacomozzi C. Tele-rehabilitation: present and future. In *Annali dell'Istituto Superiore di Sanità*, 2008, 44(2):125-34.