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ORIGINAL ARTICLE

# Designing a new test for contrast sensitivity function measurement with iPad

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**KEYWORDS**
Contrast sensitivity function;
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*FACT*

**Abstract**
*Purpose:* To introduce a new application (*ClinicCSF*) to measure Contrast Sensitivity Function (CSF) with tablet devices, and to compare it against the *Functional Acuity Contrast Test (FACT)*.
*Methods:* A total of 42 subjects were arranged in two groups of 21 individuals. Different versions of the *ClinicCSF (.v1 and .v2)* were used to measure the CSF of each group with the same iPad and the results were compared with those measured with the *FACT*. The agreements between *ClinicCSF* and *FACT* for spatial frequencies of 3, 6, 12 and 18 cycles per degree (cpd) were represented by Bland–Altman plots.
*Results:* Statistically significant differences in CSF of both groups were found due to the change of the *ClinicCSF* version ($p < 0.05$) while no differences were manifested with the use of the same *FACT* test. The best agreement with the *FACT* was found with the *ClinicCSF.v2* with no significant differences in all the evaluated spatial frequencies. However, the 95% confidence intervals for mean differences between *ClinicCSF* and *FACT* were lower for the version which incorporated a staircase psychophysical method (*ClinicCSF.v1*), mainly for spatial frequencies of 6, 12 and 18 cpd.
*Conclusions:* The new *ClinicCSF* application for iPad retina showed no significant differences with *FACT* test when the same contrast sensitivity steps were used. In addition, it is shown that the accurateness of a vision screening could be improved with the use of an appropriate psychophysical method.
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**PALABRAS CLAVE**
Función de sensibilidad al contraste;
Desempeño visual;
Dispositivos de tableta;
iPad;
*EFAC*

**Diseño de una nueva prueba para medir la función de sensibilidad al contraste con iPad**

**Resumen**
*Objetivo:* Introducir una nueva aplicación (*ClinicCSF*) para medir la Función de Sensibilidad al Contraste (FSC) con dispositivos de tableta, y compararla con el test *Functional Acuity Contrast Test* (*FACT*).
*Métodos:* Se distribuyeron 42 sujetos en dos grupos de 21 personas. Se utilizaron diferentes versiones del *ClinicCSF (.v1 y .v2)* para medir la FSC de cada grupo con el mismo iPad, comparándose los resultados obtenidos con los medidos con el test *FACT*. Se representaron las concordancias entre *ClinicCSF* y *FACT* para frecuencias espaciales de 3, 6, 12 y 18 ciclos por grado (cpg) mediante gráficos de Bland–Altman.
*Resultados:* Se hallaron diferencias de FSC estadísticamente significativas en ambos grupos debido al cambio de versión del *ClinicCSF* ($p < 0.05$), mientras que no se manifestaron diferencias con el test *FACT*. La mejor concordancia con el *FACT* se obtuvo con el *ClinicCSF.v2*, no hallándose diferencias significativas en todas las frecuencias espaciales evaluadas. Sin embargo, los intervalos de confianza del 95% para las diferencias medias entre *ClinicCSF* y *FACT* fueron inferiores para la versión que incorporó un método psicofísico de escalera (*ClinicCSF.v1*), principalmente para frecuencias espaciales de 6, 12 y 18 cpg.
*Conclusiones:* La nueva aplicación *ClinicCSF* para el iPad retina no reflejó diferencias significativas con el test *FACT* al utilizar los mismos pasos de sensibilidad al contraste. Además, la precisión del examen visual puede mejorarse con el uso de un método psicofísico adecuado.
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## Introduction

The Contrast Sensitivity Function (CSF) has been generally accepted as a better predictor of visual performance than high contrast Visual Acuity (VA). In fact, VA is usually considered as a measure of the clarity of vision, and it basically depends on the finest detail that an eye can resolve. On the other hand, the CSF is a more complete metric since it is a measure of the threshold contrast needed to see spatially varying stimuli.[1] Indeed, the CSF is nowadays considered a routine clinical tool in optical quality assessment of the eye[2,3] and in eye disease detection (e.g., cataracts,[4] optic nerve pathologies,[5,6] retinitis pigmentosa,[7,8] glaucoma,[9,10] etc.).

When CSF testing was initially introduced in clinical practice and clinical research, tests usually consisted of computer-generated visual images. However, those devices were typically costly, they needed a calibration and normative data that were not readily available. Consequently, chart-based methods for assessing CSF were developed in the early 1980s.[11]

In clinical practice, Contrast Sensitivity (CS) is generally measured by means of optotypes of different contrast, such as Pelli-Robson Chart[12] or by means of sinusoidal gratings of different spatial frequency.[13] The main difference between them is that an optotype contains a wide range of spatial frequencies whose relative weights depend on the letter and its size, while a sinusoidal grating evaluates the response of the visual system to a single spatial frequency.[14]

Today, the most popular commercial tests for measuring CSF by means of sinusoidal gratings are: Functional Acuity Contrast Test (*FACT*),[15] and the Vector Vision CSV-1000 (VectorVision, Greenville, OH).[16] These tests commonly use 9 patches for each spatial frequency but they differ in: the specific spatial frequencies evaluated, in the step contrast sizes and ranges, and in the psychophysical method to achieve the threshold.

Since tablets appeared, new applications (apps) have been proposed in the ophthalmology and optometry practice.[17,18] The great advantages of these devices are that they offer the possibility to standardize vision screenings, and since there are many common models which share characteristics such as screen chromaticity and resolution, the chromatic properties of such devices might be assumed to be nearly the same. The aim of this study is to introduce a new App, called *ClinicCSF*[19] to measure CSF with tablet devices and to compare it with other commercial device: the *Optec Visual Function Analyzer (Stereooptical, Chicago)*[20] that contains the *FACT*.

## Methods

### Subjects and instruments

Forty-two subjects divided into two groups participated in this study. Subjects from the Group 1 (mean age, $33 \pm 12$ years) were examined by a trained optometrist with the *ClinicCSF.v1* in an optometry center. Subjects from the Group 2, members of the staff and students from the

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