# First results of automated RAPD-SWIFT method in dynamic pupillometry

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## Abstract

**Background:** *This paper presents preliminary observations on the use of a commercial pupillometric instrument (Albomed PupilX) for the detection and quantification of Relative Afferent Pupillary Defect (RAPD). In this pilot study, video-based pupillometry was used in conjunction with calibrated LED illumination to simulate the effects of the traditional swinging-flashlight test using neutral density filters.*

**Methods:** *The results presented in this study follow a method described by Wilhelm et al. (Tübingen SWIFT-test) in which the eyes are illuminated alternately and the response in pupil diameter measured by video pupillometry. Using the PupilX instrument, the LED intensity can be programmed in logarithmic steps starting from a maximum intensity of 1000 lux (lx), with each reduction of 50% in illumination intensity corresponding to a 0.3 log-units increase in filter density.*

**Results:** *The eyes were stimulated unilaterally with illumination intensities corresponding to a neutral density range of 0.0 to 0.9 log-units. In all normal subjects a symmetrical pupil reaction was seen, independent of which eye was stimulated. In contrast, in a subject with known RAPD, a clear asymmetry in the reaction to stimulation of the left and the right eyes was seen.*

**Conclusions:** *These measurements were compared with typical results from the original Tübingen SWIFT study and good qualitative agreement was seen. Furthermore, the*

## Erste Ergebnisse einer automatischen RAPD-SWIFT-Methode in dynamischer Pupillometrie

## Zusammenfassung

**Hintergrund und Zielsetzung:** *Wir präsentieren erste Ergebnisse einer Pilotstudie über die Verwendung eines kommerziellen Pupillometers (PupilX, Albomed) für den Nachweis und die Quantifizierung des relativen afferenten Pupillendefektes (RAPD).*
*In dieser Untersuchung wurde die videogestützte Pupillometrie in Verbindung mit einer geregelten LED-Beleuchtung eingesetzt, um den traditionellen Wechselbelichtungstest (Swinging-Flashlight-Test) mit Graufiltern für den RAPD zu simulieren.*

**Methoden:** *Die Ergebnisse in dieser Studie folgen einer von Wilhelm et al. beschriebenen Methode (Tübingen SWIFT Test), in der die Augen abwechselnd beleuchtet wurden und die entsprechende Reaktion des Pupillendurchmessers mittels videounterstützter Pupillometrie gemessen wurde.*
*Mit dem PupilX kann die LED-Intensität in logarithmischen Stufen bis zu einem Wert von 1000 lux (lx) programmiert werden: eine 50% Abschwächung in der Lichtintensität entspricht jeweils mit einem Graufilter mit 0,3 Log-Einheiten.*

**Ergebnisse:** *Die Augen wurden jeweils mit Lichtintensitäten im Bereich 0 – 0,9 Log-Einheiten einseitig*

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*method can clearly differentiate between healthy subjects and those with a known RAPD, indicating that the PupilX, programmed with specific stimulus sequences and in conjunction with a suitable analysis software, has the potential for recognition and quantification of RAPD, and prompting the suggestion for further study involving a range of patients including both normal subjects and those with a known and quantified RAPD.*

**Keywords:** Pupillometry, RAPD, relative afferent pupillary defect, swinging flashlight test

*stimuliert. Bei allen normalen Patienten wurde eine symmetrische Pupillenreaktion gesehen: die Antwort war identisch unabhängig davon welches Auge stimuliert wurde. Im Gegensatz dazu zeigten RAPD-Patienten eine klare Asymmetrie zwischen den Antworten auf die Stimulation des linken und rechten Auges.*

**Diskussion:** *Unsere Ergebnisse zeigen eine gute qualitative Übereinstimmung mit der Tübingen SWIFT-Studie. Zusätzlich ist das Verfahren in der Lage, zwischen gesunden Probanden und Patienten mit einem bekannten RAPD zu unterscheiden, was darauf hinweist, dass das PupilX mit bestimmten Stimulus-Sequenzen und in Verbindung mit einer geeigneten Analysesoftware das Potenzial für eine Erkennung eines RAPD-Befundes hat. Weitere Studien mit einer umfangreichen Studienpopulation müssen zeigen, ob sich mit dem Verfahren RAPD sicher quantifizieren lässt und RAPD-Befunde zuverlässig von Normalbefunden getrennt werden können.*

**Schlüsselwörter:** Pupillometrie, RAPD, Relativer afferenter Pupillendefekt, Wechselbelichtungstest

## Background and purpose

A Relative Afferent Pupillary Defect (RAPD) is a condition affecting the pathway from the eye to the visual cortex in the brain. Often occurring unilaterally, an RAPD manifests itself as a reduced sensitivity to visual stimuli with a corresponding reduction in the pupillary reflex. Normally, a stimulus such as a brief flash of light in one eye causes both pupils to contract (the *consensual reflex*). With an RAPD the reduced sensitivity on the affected side results in a weaker response, seen as a smaller depth of pupillary contraction when the eye on that side is stimulated. An RAPD can be caused by, and is indicative of, conditions such as optic neuritis (Marcus Gunn pupil), unilateral glaucoma and retinal disease [1,2].

The established method for the detection and quantification of the RAPD involves the use of neutral density filters in conjunction with alternate illumination of the left and right eyes, usually achieved manually (the *swinging flashlight test*) [1,2]. In this test, the operator directs the light from a handheld flashlight alternately into the right and left eyes and the pupil reaction is assessed visually. A weaker pupil reflex to stimulation of one eye in comparison with the other indicates the presence of an RAPD. The extent of the RAPD can be estimated by placing a neutral density filter in front of the eye that produces the larger response, thus reducing the intensity of the stimulus. The severity of the RAPD can then be assessed as strength of filter required to equalise the response to stimuli on either side. This traditional test is well established but is subjective and relies on the skill of the operator to interpret the pupil constriction visually.

Earlier and more reliable detection of RAPD would enable the earlier application of the appropriate treatments such as steroid therapy for optic neuritis, antibiotics in the case of infection or miotic eye drops to relieve pressure in glaucoma. An objective and quantitative measure of RAPD would also enable more accurate monitoring of the progress and effectiveness of treatment in these cases.

Binocular video pupillometry offers the opportunity for a reproducible and objective RAPD measurement. In 2001, Wilhelm et al. [3] described an automated process named SWIFT (for SWInging-Flashlight-Test) based on video pupillometry and computer analysis. This system uses light emitting diodes (LEDs) in front of the eyes with the intensities and timings of the illumination controlled to produce a reproducible swinging flashlight cycle with a brief pause between illumination phases. The 2001 paper [3] describes a measurement cycle of 2.5 seconds consisting of 2.0 s illumination followed by 0.5 s darkness, with the illumination phase alternating between left and right. The amplitude of pupil constriction following the onset of each light pulse is measured and the LED intensity varied to reproduce the effect of the neutral density filter. The RAPD value is then calculated in terms of the intensity difference required to equalise the amplitude of the pupil response.

This SWIFT system was used in 2007 by the Tübingen group to establish the range of RAPD values present in a sample of 102 normal subjects [4] in order to compile a representative sample of normative data.

The purpose of the current study was to reproduce this SWIFT process using a novel digital binocular pupillometer