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New insight on the underdrawing of 16th Flemish-Portuguese easel paintings by combined surface analysis and microanalytical techniques

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ABSTRACT

This paper focusses on the study of the underdrawings of 16th century easel paintings attributed to the workshop of the Portuguese-Flemish Master *Frei Carlos*. This investigation encompasses multidisciplinary research that relates the results of surface exams (infrared reflectography, standard light photography and infrared photography) with analytical investigations.

The surface analysis of *Frei Carlos*' underdrawings by infrared reflectography has shown heterogeneous work, revealing two different situations: (1) an abundant and expressive underdrawing, revealing a Flemish influence and (2) a simple and outlined underdrawing. This preliminary research raised an important question related to this Portuguese-Flemish workshop and to the analytical approach: Is the underdrawing's heterogeneity, as observed in the reflectograms, related to different artists or is this rather an effect that is produced due to the use of different materials in the underdrawing's execution? Consequently, if different materials were used, how can we have access to the hidden underdrawings? In order to understand the reasons for this dissemblance, chemical analysis of micro-samples collected in underdrawing areas and representing both situations were carried out by optical microscopy, micro Fourier transform infrared spectroscopy (μ-FTIR), scanning electron microscopy coupled with energy dispersive X-ray spectrometry (SEM-EDX) and micro-Raman spectroscopy (μ-Raman). Taking into account the different possibilities and practical and theoretical limitations of surface and punctual examinations in the study of easel painting underdrawings, the methodology of research was adjusted, sometimes resulting in a re-analysis of experimental results. This research shows the importance of combining multispectral surface exams and chemical analysis in the understanding of the artistic creative processes of 16th century easel paintings.

1. Introduction

Underdrawings are the preliminary drawings on the panels (or canvas) and much of interest in this study lies in what they reveal about the creative processes of the artist, providing important information about workshops and developments in a certain time period (Bomford et al., 2002; Kammerer et al., 2007).

Infrared reflectography has been the technique most widely used for revealing and studying underdrawings. Since its development in the late of 60s of the twentieth century by the Dutch physicist Van Asperen de Boer (Boer, 1968, 1970), the infrared reflectography technique has been an important tool for the *in situ* analysis and diagnosis of works of art (Faries, 2005), allowing to reveal the underdrawings under layers of paint through selective reflection/absorption of infrared radiation by the various constituent materials. Drawing, strokes, signatures, inscriptions, mechanical transfer processes, *pentimenti* and changes of composition hidden beneath layers of paint can be observed and revealed, allowing a deeper knowledge of the technique of an artist or

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workshop. Another important aspect concerns to the style of the underdrawing, whether the underdrawing is a simple sketch, free-hand or rather methodical and orderly. Finally, another important issue concerns to the identification of the materials and drawing tools used in the creation of the underdrawing (Bomford et al., 2002; Fischer and Kakoulli, 2006; Kammerer et al., 2007; Candeias et al., 2011).

The nature of materials used in the underdrawings execution usually involves analytical research, which includes micro-sampling, microscopy observations and micro-analysis. It is not always possible to collect micro-samples and, even when it is possible, very small amounts of sample are obtained and even much smaller amounts of underdrawing material are available for analysis. Additionally, one has to take into account the fact that the underdrawing is located between paint layers and therefore one has to consider the nature of materials present in adjacent layers, which could not only hamper its visibility through infrared imaging tools but also they could compromise somehow the analytical data. On the other hand, a number of materials used to create underdrawing designs are based on some form of carbon and sometimes, even with a deeper chemical analysis, it is not possible to distinguish between them (Bomford et al., 2002). At this level, both surface analysis by infrared light and micro-analytical research should be complemented by each other, giving information on the response of the drawing materials at infrared light (e.g. visible or not visible, dry or fluid) and relating this to their optical properties and chemical composition (Bomford et al., 2002). More difficult is the identification of carbon and metal-based inks, as it has poor response in infrared reflectography. This hinders the micro-sampling process and also, due to the complexity of compounds that could be present (e.g. iron gall inks and respective gallatonate compounds), its chemical characterization. These seem to be the major reasons why very few, and extraordinary, analytical studies of these materials have been published (Dunkerton and Roy, 1986; Spring et al., 2009).

The characterization of the underdrawing in all those aspects could contribute, at the limit, to answer some questions related to the attribution and authentication of works of art.

This paper presents an extensive research based on the technical and material characterization of the underdrawing of sixteen century Portuguese-Flemish easel paintings attributed to *Frei Carlos*' Workshop.

Frei Carlos, one of the most important "Portuguese-Flemish Painters", working in the region of Évora (active between 1517 and 1539–40), left a large number of works that come mainly from the Espinheiro's Convent where he made the Profession of Faith (in 1517). "Portuguese-Flemish Painting" is a common expression used in the History of Portuguese art of the first third of the sixteenth century and in its most basic meaning it designates the work of Flemish Masters who settled in Portugal during the reign of King Manuel (1495–1521) contributing decisively to the process of renewal of Portuguese painting at the time (Santos, 1971). However, the designation surpasses this simple and objective perspective when it tends to transform it into a concept with higher operating interpretative ambitions, as for example, when it is suggested that such Flemish masters "adapted their work processes to the aesthetic concepts and spiritual climate prevailing in the workshops of the Portuguese masters, but without losing the qualities and technical skills acquired in the Flemish workshops where they did the learning" (Santos, 1971). Or, going further, when one considers that the "fusion of the characteristics of the two schools", Portuguese and Flemish, originated "a style, which is commonly called the Portuguese-Flemish" (Santos, 1971).

It is of utmost importance to do research that will deliver fundamental new data about the techniques of artistic production and the materiality of the works. Ultimately, it will allow us to identify possible similarities with works of Flemish painters of their time, opening up chances to determine the centres (Bruges, Ghent, Antwerp, or others) where they might have started their careers before arriving to Portugal and that the documental sources omit.

The first step to understand the *Frei Carlos*' workshop was the pioneering work of Couto (Couto, 1943) which based his attributions by combining visual examinations with surface exams, concluding that the technical and stylistic differences did not show changes in the way of painting of a single Master but instead were the result of collaboration of several officinal painters. A critical review of these arguments was later done by the Art Historian Seabra Carvalho (Carvalho, 1988–1993, 1998, 2006, 2011) which concluded that two types of pictorial preparatory drawing seemed to appear in the workshop creation, perhaps indicating a more complex internal structure. More recently, new data obtained by infrared reflectography confirm the heterogeneous creative process of this workshop and the need of a deeper resource based on the chemical composition of the materials (Candeias et al., 2011; Carvalho, 2013).

A deep investigation of this Master workshop and practices is being developed through multi-disciplinary teams combining historical research on documental sources with surface examination and material characterization using state-of-art analytical techniques. The results obtained so far highlight several similarities between *Frei Carlos*' workshop and Flemish schools, regarding materials and some particularities of the technique of artistic production (Valadas et al., 2013, 2014).

This investigation brings new perspective of the work attributed to this workshop, thought the technical and material characterization of the first sketch of an artist when he starts his work, the underdrawing.

2. Materials and methods

2.1. Surface analysis

The study of 16th Century Portuguese-Flemish paintings attributed to the Master *Frei Carlos*' workshop started with the visual examination of the paintings and surface exams, namely standard light photography, U.V. fluorescence photography, infrared reflectography, infrared photography and X-ray radiography.

Standard light photography was performed with a high resolution digital camera Nikon D3100 equipped with a CMOS sensor (DX format, 14.2 effective megapixel) and lenses AF-S DX zoom-Nikkor 18–55 mm f/3.5–5.6G ED II. Two lamps with tungsten light bulbs and 3200 K colour temperature were used to uniformly illuminate each of the paintings. The details were realized with a Nikon AF-S DX Micro Nikkor 40 mm f/2.8 lens.

The reflectograms were obtained by using a high resolution infrared reflectography camera (Osíris) with an InGaAs detector allowing a wavelength response from 900 to 1700 nm, and equipped with a $16 \times 16\,cm^2$ tile system which allows an image size of 4096×4096 pixels. The camera comes with a longpass filter Schott RG850, allowing to transmit infrared wavelength and block the undesired shorter wavelength until 850 nm. The reflectograms were performed for $45 \times 45\,cm^2$ painting area.

Infrared photography was performed with a digital camera Nikon D3100 that was made sensitive to infrared radiation by removing the low-pass filter and operating with lenses AF-S DX Micro Nikkor 40 mm f/2.8G. The infrared radiation starts on the visible radiation limit above red till hertzian waves, from 730 to 10^5 nm however, only a part can be registered by photography: the near infrared that goes till 1100 nm. This system was also coupled with low-pass infrared filters X-Nite 780, 850 and 1000 nm,