The Consequences of Wax-Resin Linings for the Present Appearance and Conservation of Seventeenth Century Netherlandish Paintings On Canvas

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Summary

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Background information

This thesis explores the conditions under which and the extent to which wax-resin linings may have altered the surface appearance of seventeenth century Netherlandish paintings. The lining of paintings is a restoration treatment meant to consolidate weakened canvas. In the Netherlands from the mid-nineteenth century, the traditional method for lining paintings involved the use of an adhesive based on a mixture of beeswax and natural resin, hence the term "wax-resin linings". Considered until the 1970's as an overall cure, wax-resin lining has been systematically applied to paintings. Practically, the techniques involves the adhesion of a new canvas to the verso of the original and the impregnation of the whole painting's structure with the wax-resin adhesive. The melting of the adhesive was achieved using hot hand held irons as a heat source.

Early in the history of wax-resin linings, documents refer to undesirable consequences of the technique, amongst which colour change of paintings is regularly reported. Nonetheless, the technique was broadly implemented until the 1970s. From the middle of the twentieth century, with the development of codes for conservation practice that viewed the drawbacks of the method as increasingly problematic, the attitude towards wax-resin lining began to change and alternative techniques for the structural treatment of paintings were developed.

Relevancy of the research

Most paintings preserved currently in the Netherlands were wax-resin lined. For example, it is estimated that 95% of paintings from the Dutch Golden Age were subjected to this technique. To date, however, there remains limited scientific research investigating the influence of wax-resin linings for the conservation of these paintings. In order to fill this gap of knowledge the present thesis examined colour change of ground layers in seventeenth century Netherlandish paintings on canvas. This focus was chosen due to the painting technique used in these works, where the ground is often left visible to be used as a middle tone or was slightly glazed to manage smooth transition between shadows and highlights. A change in tone of the ground, therefore, significantly alters the overall aesthetical character of the paintings, leading to misinterpretation of the works. Further colour change is caused by the penetration of the lining adhesive into paintings' structure. Colour change is therefore a clear sign that physical characteristics of the paint film have been fundamentally modified and therefore may require a specific conservation approach.

Goals of the research

By clarifying the conditions under which wax-resin linings may have altered the appearance of seventeenth century Netherlandish paintings, this research aimed to enable paintings conservators to recognize and understand visual changes caused by this treatment, as well as anticipating conservation problems. In addition, results of the research would provide new evidence for consideration by conservators and art historians for estimating the original appearance of the paintings, and the impact of visual changes caused by their physical history.

Hypothesis

Material evidence found in the paintings by Jacob Jordaens (1593-1678) in the Royal Palace Amsterdam provided the basis for the research hypothesis. Technical examination revealed that though the four paintings by the Flemish painter had aged in the same conditions and received similar restoration treatments, including wax-resin linings, they are today in very different physical condition. Differing degrees of darkness, which in some cases compromised an accurate reading of the depiction, was particularly striking. Technical examination also highlighted the use of various ground types that differ in both the number of layers and material composition. Interestingly, some testimonies from experienced practitioners, report that colour change of paintings after wax-resin lining may be dependent on the composition of the ground. The correlation between material evidence and documentary sources supported the hypothesis put forward in the present study that the visual consequences of wax-resin linings in seventeenth century Netherlandish canvas paintings is related to the original preparation technique. Previous studies that have addressed this question include work completed in the 1980s by the National Gallery, London, and in 2010 by the Van Gogh Museum, Amsterdam. These studies provided a basis on which to develop the present research by providing information about experimental samples and methods for colour measurements.

Research methodology

The present study takes into consideration three main factors. Firstly, the material and physical characteristics of ground layers for canvas paintings produced in the Netherlands during the seventeenth century. Secondly, the physical modifications that may become manifest in these ground layers as a consequence of natural ageing and/or restoration treatments before wax-resin was implemented. And finally, the different methods for wax-resin lining used by paintings conservators in the Netherlands from the mid-nineteenth century until the 1970s. In order to examine the influence of each of these factors, the research methodology included technical examination of seventeenth Netherlandish canvas paintings, study of historic documents, practical experiments on reconstructions and instrumental analyses.

Central to the research's approach was the study of visual phenomena observed on reconstructions which were manufactured using materials and techniques based on material evidence from paintings selected for their relevance to the research. These included works by Jacob Jordaens, including the four paintings produced in the 1660s for Amsterdam's city hall (today's Royal Palace Amsterdam) and *Susanna and the Two Elders*, 1653, National Gallery of Denmark. In addition, the list comprised paintings by Gerard van Honthorst (1592-1656) and Theodor van Thulden (1606-1678) created in 1648-1651 for the Oranjezaal as well as *The Night Watch,* 1642, by Rembrandt in the Rijksmuseum, Amsterdam. Ground recipes found in documentary sources from the period and results of technical research from other paintings were also incorporated.

The materials selected for the manufacturing of reconstructions included nine different pigment types: chalk, lead white, raw umber, yellow iron oxide, red iron oxide, tile red, charcoal black, quartz sand and two types of clay. Two types of binding media were also used - namely linseed oil and animal glue. Pigments were used either independently or in mixtures of various ratios.

The degree to which the ground layers obliterate the darkened underlying canvas support (hiding power) was hypothesised to be a key parameter in the colour change of ground layers. In order

to investigate the influence of grounds' hiding power on colour change after impregnation, compositions were applied in different thicknesses onto canvas support. In addition, a pilot-study included the systematic application of different thicknesses onto opacity charts. The lining procedure used on reconstructions resulted from research into historical practices, though it occasionally had to be altered in order to minimize variables.
Colour measurements were recorded with a spectrophotometer. The CIELAB colour space was used and colour differences were calculated using the 1976 CIELAB colour difference equation. The colour data gathered was evaluated holistically and took into account results from measurements of ground samples on opacity charts. In addition, cross-sections of paint samples taken from the reconstructions were also analysed using light microscopy, providing further insight into the impact of layer thickness. Results were then compared with physical characteristics of real paintings in order to test their validity.

Results

Results from the experiments showed that wax-resin impregnation caused colour change in several of the ground reconstructions tested. Comparative colour measurements of the reconstructions showed that, in most of the cases, the L*, a* and b* values of the grounds decreased after impregnation indicating that the colour of grounds became darker and cooler in hue. Study of the results of colour measurements showed that the extent of change was influenced by the type of binding medium and inorganic components as well as the proportion of the latter. Furthermore, results of the hiding power study showed that all grounds types that underwent colour change after impregnation had poor hiding power, supporting the hypothesis that the hiding power of the ground affects colour change. The change in hue of the reconstructions toward cooler tones was considered an additional sign for the influence of the hiding power as this might be due to a turbid medium effect that typically occurs when a light toned thin paint covers a darker and warmer layer underneath.
Colour measurements of ground reconstructions showed that the glue-bound grounds changed colour more significantly than oil-bound grounds. It was assumed that the increased absorbency of these grounds compared with grounds composed of linseed oil caused this difference in colour change. The filling in of the voids inherently present in the glue-bound ground with wax-resin resulted in changes of refractive index and surface texture. These two phenomena were assumed to have exacerbated the colour change measured in the animal glue-bound grounds compared with the oil-bound grounds into which the wax-resin did not penetrate.
Of the ground reconstructions bound in animal glue, the one composed of chalk changed most significantly after wax-resin impregnation. This reconstruction is the only case where the change in hue was towards a more yellow and red colour. Of the ground reconstructions bound in linseed oil, those composed of either chalk or ball clay measured the most significantly altered after treatment, followed by the lead white and Maas river clay containing grounds which changed only slightly, while the grounds composed of either red iron oxide, yellow iron oxide, raw umber or charcoal black did not undergo change.
Research also found that the ratio of chalk to either yellow iron oxide, raw umber, lead white or yellow iron oxide and raw umber used in combination, was a significant factor in the colour change of oil-bound ground layers composed of pigment mixtures. Colour measurements showed that, in general, the higher the concentration of chalk the more significant the colour change. Furthermore, the results suggested that the impact of the inclusion of chalk on the

degree of colour change was dependent on the pigment that it was mixed with, for example no colour change was measured in ground reconstructions composed of chalk and raw umber. The hiding power study supported these results as trends indicated that the higher the proportion of chalk the more poorly the ground hid the substrate it was applied on. The minimum proportion of chalk at which colour change was measured varied depending on the other components in the ground. Colour measurements also showed that the inclusion of 10% raw umber to the ground composed of lead white and chalk prevented colour change completely, as no colour difference was measured even when the proportions of chalk were 50 and 70%.

Each quartz containing oil-bound ground reconstruction showed substantial colour change following wax-resin impregnation. The colour change in grounds of this type was amongst the most significant of all oil-bound grounds tested. Trends indicated that the higher the concentration of quartz the greater the colour change of the grounds after impregnation. Although the inclusion of 3% yellow iron oxide tended to reduce this effect, the colour change of the grounds remained significant. The hiding power study indicated that the higher the concentration of quartz, the poorer the hiding power, supporting the influence of hiding power on the colour change of the reconstructions.

Research also found that the influence of thickness varied according to the kinds and proportion of the inorganic components in the ground. For example, the ground composed of chalk in animal glue changed colour more significantly when applied thinly. Similar trends were found for the oil-bound grounds composed of either ball clay or lead white, 98% chalk mixed with either yellow iron oxide or combinations of yellow iron oxide and raw umber in equal amounts, as well as 80% chalk with lead white. On the contrary, layer thickness did not influence the degree of colour change of oil-bound ground composed of lead white and raw umber (even with 70% chalk). Finally, the quartz and ball clay containing oil-bound grounds changed colour to a similar extent regardless of the thickness of application.

The hiding power study showed that layer thickness considerably influenced the hiding power of certain grounds under investigation. A general trend was that the thinner the ground the less hiding it was, therefore supporting results of colour measurements from the reconstructions on canvas support. An exception was the ground composed of chalk and yellow iron oxide in linseed oil for which colour measurements were not decisive.

Evaluation

Results of colour measurements of ground reconstructions rarely showed an exact match with the grounds of historical paintings. Though the composition of the reconstructions was based on material evidence found in seventeenth century Netherlandish paintings, factors that differentiate the reconstructions from the real paintings were significant and precluded inferences about the original colour of the ground of paintings before lining.

Instead, analysis of the research findings enabled the identification of trends that can predict the likelihood that paintings with certain ground characteristics have been visually altered by wax-resin impregnation. For future research it would be very interesting to broaden the type of grounds investigated. For example: lead white containing oil-bound grounds with varying pigment mixtures and proportions of chalk, red grounds and double grounds.

The research also showed that the "abraded look" of the surface of a ground could be a phenomenon resulting from wax-resin impregnation.

It now appears that the presence of adhesive in the canvas structure resulting in the darkening of the support is a cause for the alteration of the appearance of paintings. Correction of this effect could involve extracting wax-resin from the painting's structure, assuming that this treatment might reveal the original colour of the priming. Past research on that topic has not been decisive and questions remain as to whether a full extraction would really return the painting to pre-lining colour, and if such an approach may expose paintings to high risks of delamination.
Key to the interpretation of visual phenomena was the correlation of colour measurements of ground reconstructions on canvas support with measurements of the same grounds applied on opacity charts. This allowed analysis of the influence of ground layers hiding power regarding the degree of colour change. Whether colour change in oil-bound ground is only due to the original hiding power of these ground types or whether this property was changed by the impregnation of wax-resin in the ground was not clarified. Therefore, the characterisation of the degree of wax-resin impregnation in oil-bound grounds is an area for future research. This question coupled with the porosity of oil-bound grounds is very relevant since their porosity is suspected to increase with ageing resulting in favourable conditions for colour change. This research could be carried out by a systematic comparative study of both lined and unlined paintings.

Conclusion

Paintings conservators world-wide are often confronted with the conservation of paintings that have been wax-resin lined and are treating such paintings despite a lack of scientific research on the overall consequences of the technique for present conservation. The present study is only a start in a broader field of research into the impact of the physical modification of the wax-resin adhesive on the conservation of paintings today. More insight based on scientific research is therefore essential and timely. Research into the effects of wax-resin linings includes numerous lines of study, each of which have a high level of significance for paintings conservation, conservation history and art history. In order to maximize the benefits for different fields of interest, it is crucial to investigate these lines in an integrated and concerted manner. While new knowledge is required, one should not forget that significant aspects have already been investigated, especially with regard to the history of the technique. This information is, however, spread between various institutes and the creation of a place of reference for the conservation of wax-resin lined paintings could help to remedy this. It would centralize and coordinate existing information on the history and conservation of wax-resin lined paintings, as well as create new knowledge integrated with past research. The creation of such a centre in the Conservation-Restoration department at the University of Amsterdam is not only relevant because of the history of wax-resin linings that is tightly connected with the Netherlands but also due to the fundamental role of the University in carrying out scientific research and supporting the sharing and dissemination of knowledge.