TRACKING PATTERNS & CREATING CLUSTERS

STUDY OF MATERIALS AND HISTORICAL DATA FROM VILHELM HAMMERSHØI'S PAINTINGS

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By applying advanced data mining techniques to chemical data from SEM-EDXS of the ground layers in Vilhelm Hammershøi's paintings, in combination with weave maps and art historical data, patterns and clusters that shed new light on the artist's materials and working practices were revealed

Introduction & background
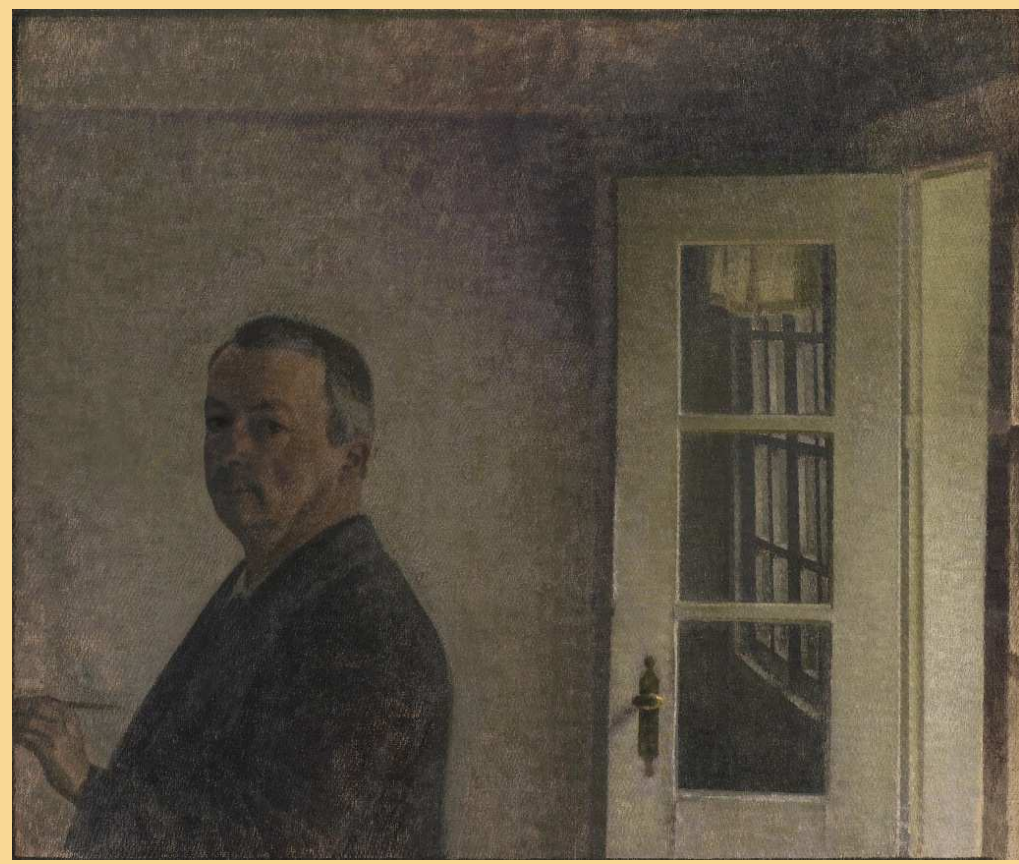
Vilhelm Hammershøi. *Self-Portrait. The Cottage Spurveskjul at Sorgenfri, North of Copenhagen.* Oil on canvas, 126 x 149,5 cm. SMK

The Vilhelm Hammershøi Digital Archive (ViHDA) project, a 5-year research study launched in 2020, is being carried out at the National Gallery of Denmark (SMK) by a cross-disciplinary team of scientists, paintings conservators, imaging specialists, art historians and digital experts. In collaboration with Danish museums and private collectors, as well as museums and owners abroad, who hold works of art by the renowned Danish painter Vilhelm Hammershøi (1864-1916), the project has so far investigated more than 140 paintings by the artist through a systematic visual, technical and scientific examination.

This study aimed to combine art historical research, material analysis and computational techniques to identify distinct phases in the Danish artist Vilhelm Hammershøi's career, revealing patterns in his choice of motifs and painting materials, particularly canvases and ground layers, across a large selection of his works.

Methodology

Data collection
- Close to 140 paintings from museums and private collections
- X-radiography for canvas weave analysis
- SEM-EDXS for ground layer chemical analysis
- Art historical data (date, place of creation and motif)

Data management
- Development of a relational database
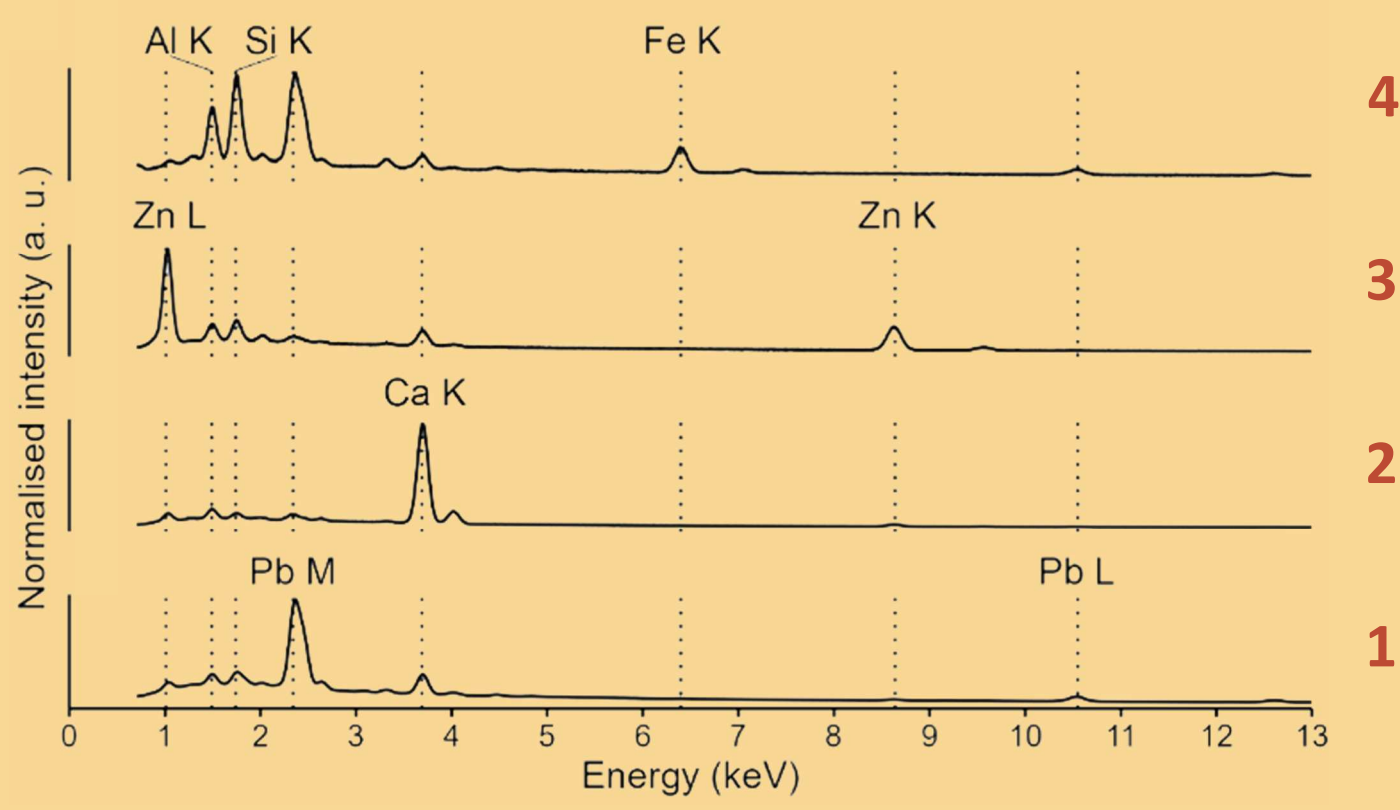- Integration of historical, structural and chemical data

Data analysis
- Use of self-organizing maps coupled with hierarchical cluster analysis (SOMHCA)
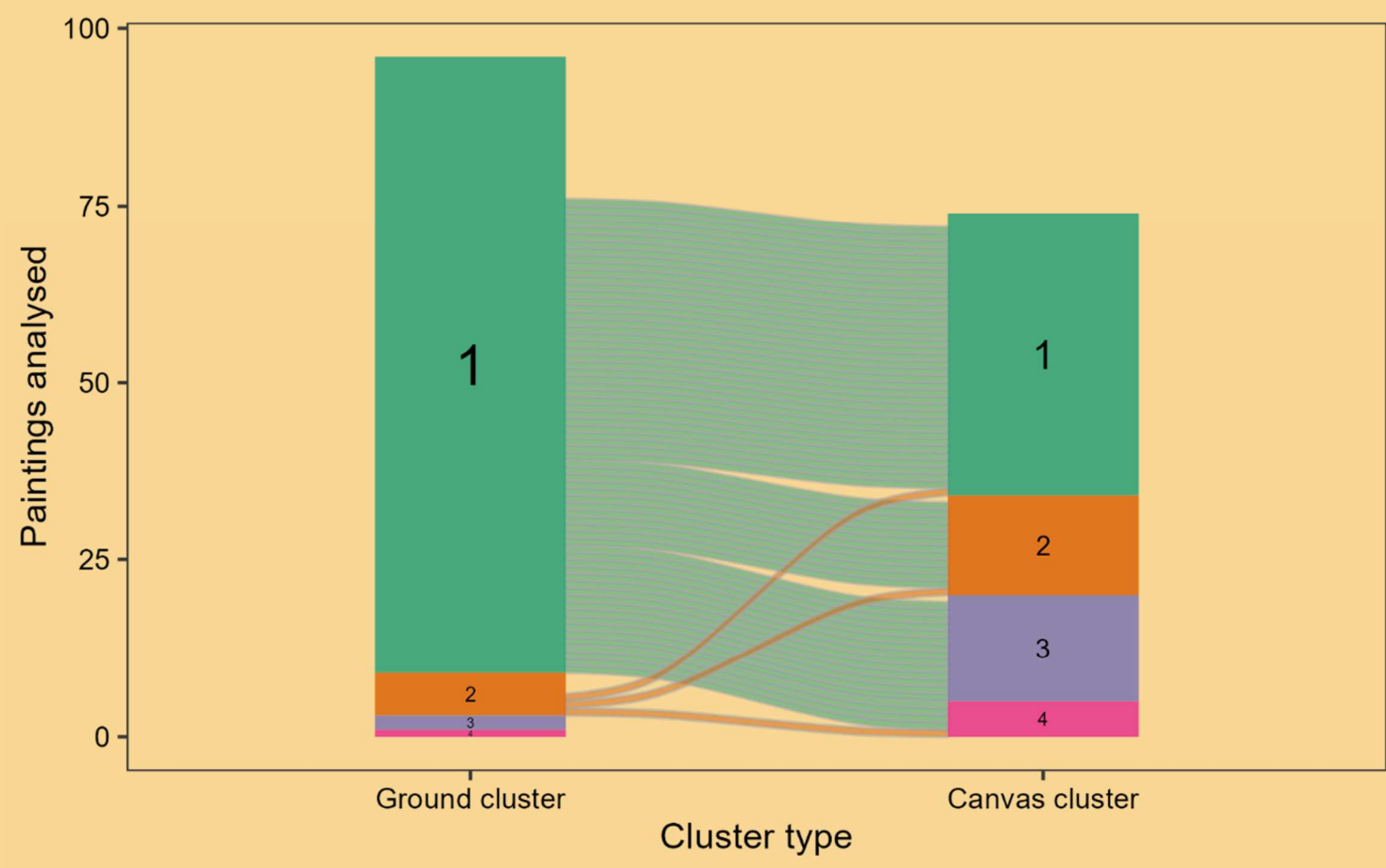- Network analysis for painting relationships

SEM-EDXS elemental maps

X-radiography   Canvas weave analysis
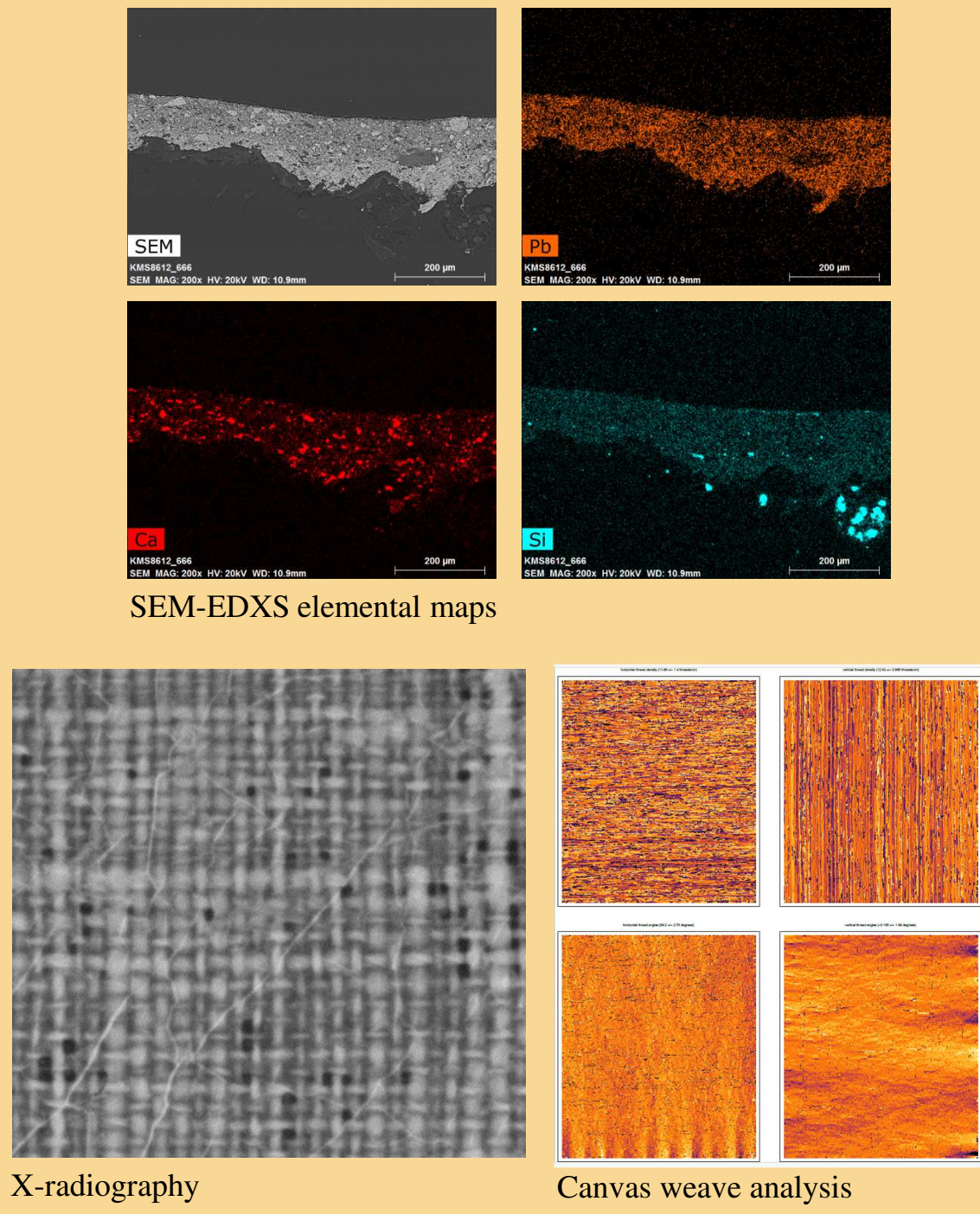
Analysis

Clusters in ground layer composition
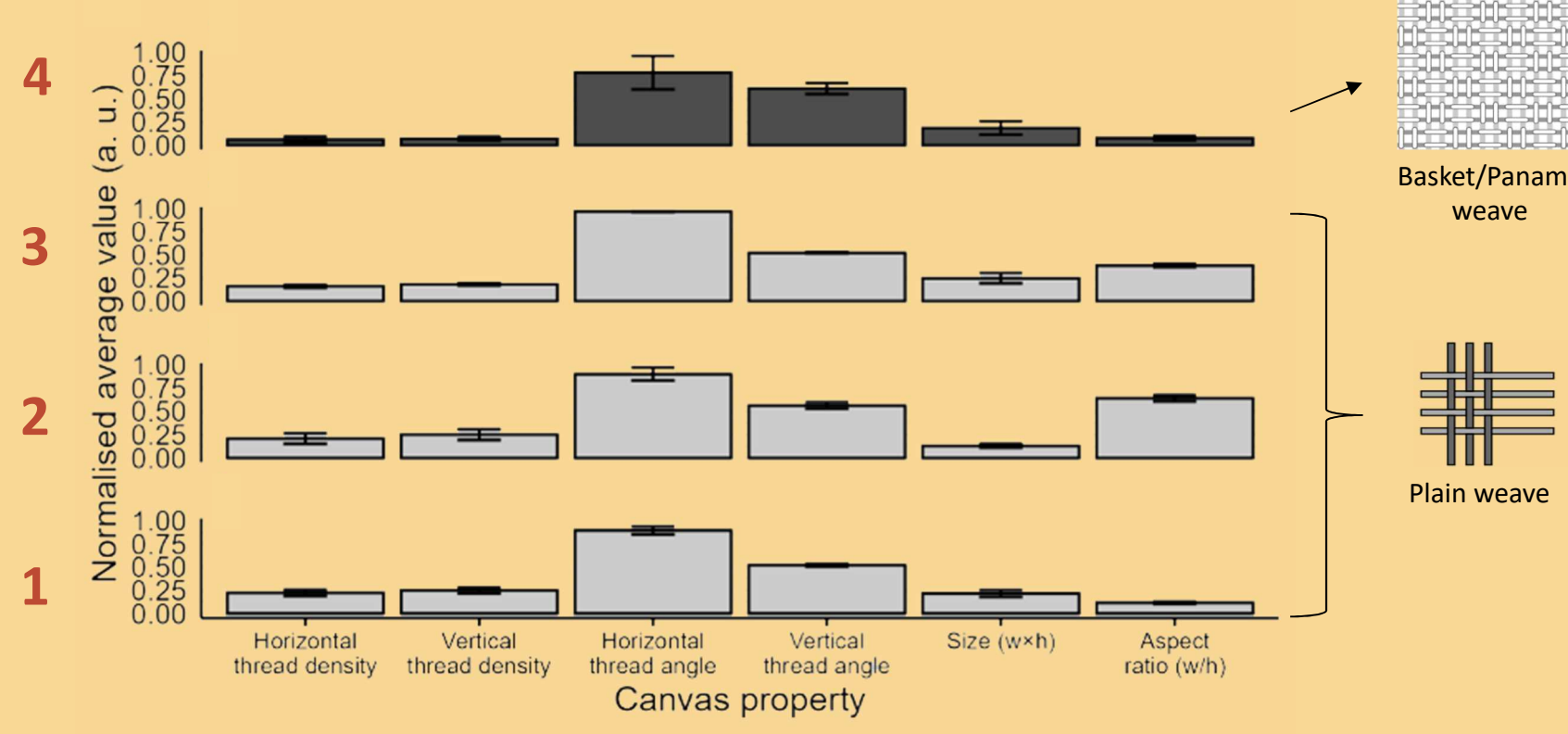

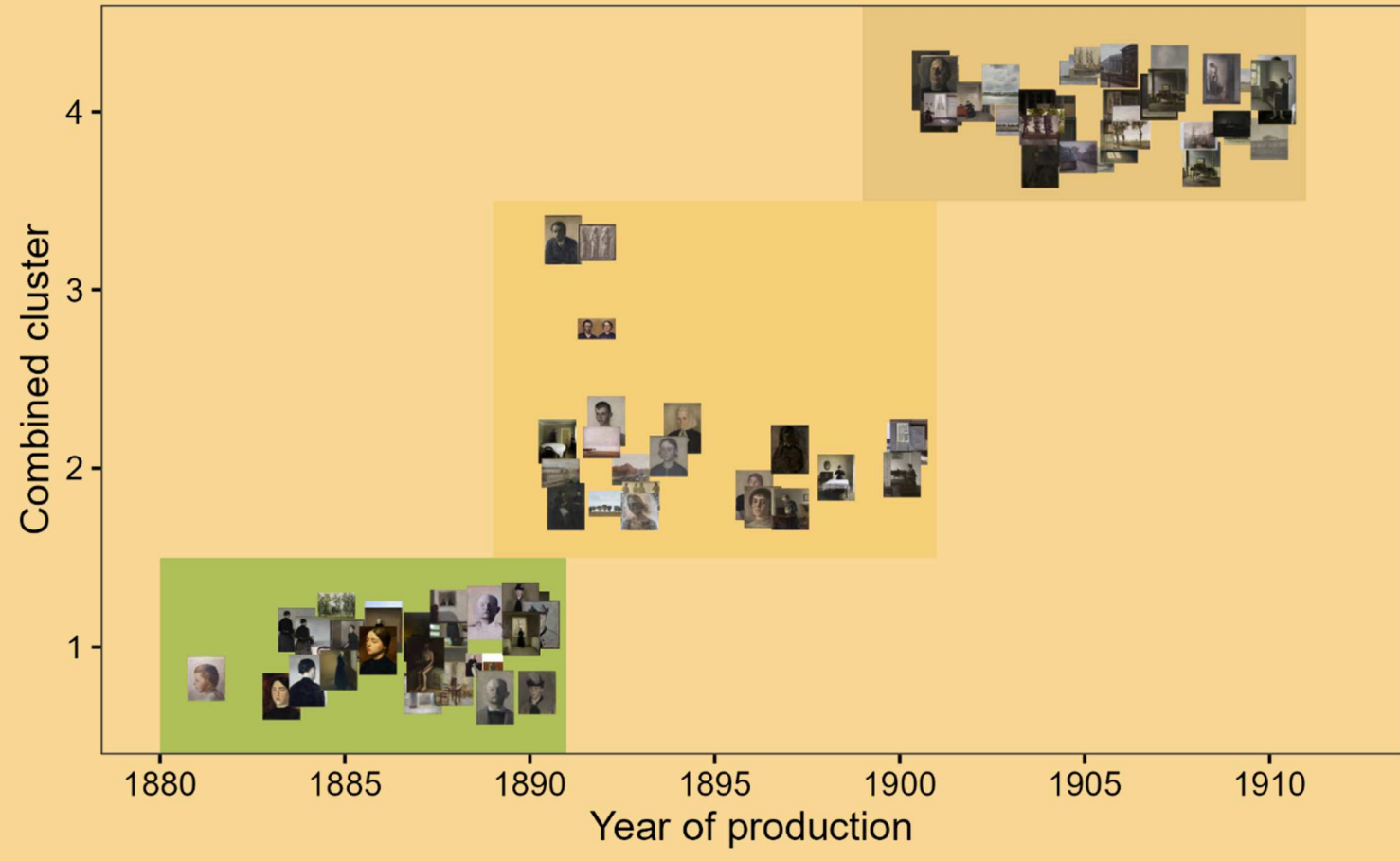### Cluster connections from ground to canvas

NETWORK ANALYSIS

Clusters in canvas properties

Timeline of paintings by production phase

Results

A timeline-based visualisation revealed three main artistic phases in Hammershøi's career, each lasting about a decade:

1. The first phase (c. 1880–1890) focused on portraits and included dense plain-weave canvases with lead- or zinc-based grounds

2. The second phase (c. 1890–1900) introduced new materials like basket weave canvases and calcium- or purer lead-rich grounds, with expanded motifs such as interiors and landscapes

3. The third phase (c. 1900–1910) showed a balanced mix of portraits, interiors and landscapes, continuing the use of plain-weave canvases and grounds with no or little calcium carbonate added

Conclusion

Systematic Study
First comprehensive analysis linking material choices with Hammershøi's stylistic evolution

Career Phases Identified
Data-driven analysis revealed three distinct phases in Hammershøi's career
Highlights the influence of travel and material availability on artistic choices

Insights into Artistic Process
Enhanced understanding of the genesis of Hammershøi's works
Clear connection between Hammershøi's artistic development and material choices

Conservation Benefits
Provides a valuable tool for assessing the condition of the artist's paintings
Supports the development of targeted conservation strategies

Acknowledgements

Contact

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Anne Haack Christensen, Paintings conservator: ahc@smk.dk

SMK — Statens Museum for Kunst, National Gallery of Denmark

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