Nonverbal Communication in Medieval Illustrations Revisited by Computer Vision and Art History

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This contribution discusses how computer vision combined with art history can analyze the visual codes and artistic representations of embodied communication represented in medieval culture. Our computer-based detection algorithms are able to search directly for gestures in images and thus avoid limitations of retrieval systems that search only textual annotations. As a result, art history is provided not only with a system that enables efficient access to large image datasets, but also a quantitative analysis of the variability and interrelation among gestures or between gestures and other objects.

We base our approach on one of four illustrated manuscripts of Eike von Repgow's (ca. 1180–ca. 1235) *Sachsenspiegel* (Mirror of the Saxons), which reveals a visual grammar that arranges the gestures to a certain extent, but within that framework, the drafter composes freely and with artistic perspective.

The illustrated manuscripts of the *Sachsenspiegel* (Mirror of the Saxons)—the most significant medieval vernacular law book in the German language, written by Eike von Repgow (ca. 1180–ca. 1235)—have been popularized through exhibitions, facsimiles, and digitized publication on the Internet.[1] A number of individual studies and long-term research projects have provided additional valuable insight.[2] This article focuses primarily on the exemplary application of computer-based object retrieval on the Heidelberg *Sachsenspiegel* (University Library, MS Cod. Pal. Germ. 164), one of four illustrated *Sachsenspiegel* manuscripts,[3] in order to demonstrate the advancements in computer vision as verifiable with a well-documented object. The aim of computer vision is to develop algorithms that give machines the ability to analyze and understand images, often with inspiration from human vision. In this case we are interested in identifying and comparing gestures and forms represented in the manuscript and also offering possibilities for visualizing detected objects.[4]

The Heidelberg *Sachsenspiegel* depicts precise types of gestures that can also differ from each other due to the rather sketchy drawing process employed or certain compositional circumstances. Dealing with a largely standardized visual language and its exceptions raises important art historical questions concerning different ways the

consistency and semantics of the illuminations are evaluated.[5] Recent findings, which reveal that illuminations did not merely accompany their respective texts, thus encourage a closer examination of the 326 individual images of the *Sachsenspiegel*: "The illustrations in many ways go beyond Eike's wording in that they are glossing, interpreting and varying what is being said."[6] Computer-aided analysis of images provides an important tool for this critical task.

The procedure of object retrieval is well suited for understudied, large, and, until now, untagged image datasets containing repetitive or similar motifs. Visual elements can be directly retrieved by means of computer vision, enabling specific searches and reducing the need for textual annotation of the digitized data, which can be a costly part of database projects. Especially in the case of large numbers of equal or similar motifs, computer-based algorithms can probe images and provide surveys and information via statistical visualizations that shed new light on the material. In addition, by assembling series of images based on similarities, computer-based analysis can facilitate attribution. Furthermore, the content and composition within the images can be analyzed by detecting objects and their respective locations. Eventually, the development of computer-based algorithmic image analysis will force us to reconsider the role of human connoisseurship; but first and foremost computer vision can assist by processing the enormous visual data of cultural heritage.

Gesture Retrieval

"Besides the coloring, the attributes and the symbols, it is the sign language in the Codices picturati of the *Sachsenspiegel* which serves the illustrator as a code system helping him to visually translate the law text," explains Ulrike Lade-Messerschmied.[7] The signs, being a language in themselves and part of this code system, can be expected to be always recognizable. Focusing on these signs, the automatic object retrieval of the Heidelberg *Sachsenspiegel* is carried out mainly on the lines of the drawings, thus focusing on the shape of objects and disregarding inconsistent use of colors. Most attributes and symbols are not effective for the purpose of automatic image retrieval because they are displayed very inconsistently (e.g., spikes for "Gut" and "Gewere"[8]) or appear very rarely.

Gestures, by contrast, can be seen in every image containing individuals. Due to their high occurrence and strong standardization as compared to other image elements, they are particularly suitable for retrieval. Thus far, our research has identified 347 hand gestures. It is striking that the gestures are disproportionally large with respect to the rest of the bodies. They range from fairly undifferentiated gestures of speech to concrete swearing an oath and commendation gestures. Hand positions and the semantics of a gesture do not always correspond. The same gesture of speech can sometimes be shown with the palm facing upward whereas at other times the back of the hand is displayed. Some of the ambiguous hand signs can only be understood within their context, such as a pointing digit, which can either indicate an act of showing something or signify an order.

Automatic gesture retrieval that focuses exclusively on hand outlines will obviously not distinguish between these semantic differences but merely reveal different forms. Contextual analysis remains the only way of determining the meaning of individual

gestures. The detection of a reliquary resolves, for example, the ambiguity between a gesture of blessing and a very similar pointing digit.

The illustrations of the *Sachsenspiegel* can be used effectively for the retrieval of gestures due to their two-dimensional quality and high degree of standardization, while the overall scale of the represented individuals remains the same.[9] In addition, the outline of the hands is quite similar. It is merely their orientation that is different.[10] The similarity of the drawings allows images to be retrieved via object models that are flexible with regard to stylistic discrepancies. Using machine learning—how the computer learns characteristics of the images by analyzing a training set and forming its own abstractions to detect the objects in images that it has not previously seen—these models are automatically distilled from images of gestures. With this core vocabulary in place, the distinct and distinguishing parts of relevant gestures can be learned. The system can then, in a subsequent retrieval phase based on the first iteration of test images, search for the most similar forms and learn to distinguish them from their surroundings. The program selects the most representative examples by means of a statistical algorithm.

In the matching process, these models serve as abstractions of the characteristics of different gestures and enable a computer-based analysis and classification of these gestures. The resulting hypotheses, a proposed subset of images, are examined with regard to their degree of similarity. In this way, only very congruent parts of the image are considered further and verified by means of a discriminative approach that aims at distinguishing patterns of interest from others.

In our research, object retrieval was first carried out on four gestures: pointing, swearing, and two speech gestures (Figure 1). The results depended largely on the number of samples provided for the learning process. In the first pass through the data, random parts from the image are likely to yield false detections of similarities, while in subsequent analyses, the algorithm can make use of these false detections to eliminate them from

Figure 1   Pointing, swearing, and speech gestures. Detail of f.15v, Heidelberg *Sachsenspiegel* (University Library, MS Cod. Pal. Germ. 164).

further inquiry. The program therefore learns from its own mistakes. By means of a confidence value, which indicates the reliability of the respective findings and certainty that the detected pattern is actually a correct finding, the results can be sorted in descending order. In this way, the user can both estimate the efficiency of the program and detect the variability and similarities within the examined image material.

Thanks to the learning function of the algorithm, gesture retrieval can also be applied to the three other illuminated manuscript versions of the *Sachsenspiegel*. Computer vision thus allows us to analyze the methods of workshops and the processes of producing copies. The computer can, for example, retrieve and distinguish symbols of power, such as crowns and swords, from the *Codices Palatini germanici*.[11] In this way, the algorithm attributes objects to different workshops and visualizes them according to their relative similarity. The basis for the comparison of a group of interdependent manuscripts was prepared by analyzing the illuminations of the famous *Codex Manesse*, a medieval songbook illustrated about 1305 and 1340 in Zurich and later reproductions commissioned by the Swiss scholars Johann Jakob Bodmer and Johann Jakob Breitinger in 1746/1747.[12] A similar methodology has been developed for the visual identification of Florentine family crests and the comparison of brushstrokes to verify attributions.[13]

The Dynamics of the Object: Reliquary and Pedestal in the Context of the Image

Whereas the retrieval of similar objects can be improved by means of optimized learning processes and other technical configurations, graphically identical gestures cannot be securely interpreted—as already indicated—since they can have different meanings according to their context. The swearing gesture, for instance, is predictably linked with the reliquary associated with oath taking. When combined with the reliquary, this gesture can be distinguished, in many cases, from similar gestures of blessing and pointing.[14] Retrieving the reliquary in an image field thus semantically and also graphically verifies the gestures detected next to it.

The reliquary and its pedestal probably constitute the most interesting and, until now, much neglected objects of the Heidelberg *Sachsenspiegel*.[15] The variability of the object results from its context, constituted by respective law cases. The coloring matches the clothing of the individuals interacting with the reliquary and nearby objects. In the same way, the size of the pedestal complies with the surroundings: If the swearing person kneels, the size of the column shaft is reduced accordingly, while the peak of the reliquary is adapted to the height of a raised swearing hand.

Only in one instance—in the Release from the King's Ban (III, 34, § 1)—is the object marginalized (17r, 4) as it is covered largely by a royal deed and is displayed on a diminished scale and in monochrome (Figure 2). This arrangement cannot be fully explained, especially because the tower reliquary hangs in the air to give room for the number "VI" below.[16] In all likelihood, the oath on the holy relics is given second place to underline the primacy of the sealed document given to the outlaw (in the sense of medieval law) by the king in the course of evidence. In the next scene, the outlaw appears in front of the judge who has formerly ostracized him in order to inform him, in due time, about the reversal of the ban.[17] The oath that

Figure 2   Release from the King's Ban. Detail of f.17r, Heidelberg *Sachsenspiegel* (University Library, MS Cod. Pal. Germ. 164).

compels the former outlaw to call upon the judge once again—an act in his own interest—occupies only a small space in the whole process and explains the diminished depiction of the reliquary.

The scene Testimony against the Judge (II, 22, § 1) presents a counter-example for the treatment of the reliquary. The pedestal is positioned disproportionally high in the second image (7v, 2) and it is particularly ornamented in the first illumination (7v, 1; Figure 3) as the capital of the pedestal bears ornaments reminiscent of gothic crockets.
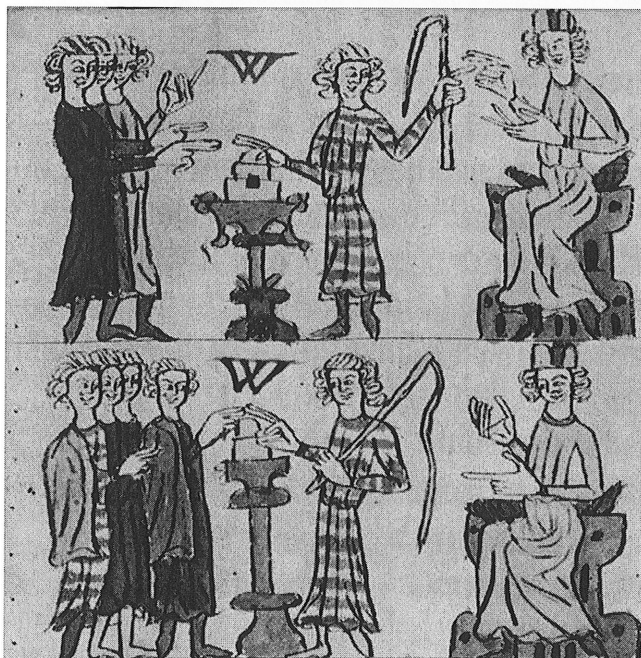
Figure 3 Testimony against the Judge. Detail of f.7v, Heidelberg *Sachsenspiegel* (University Library, MS Cod. Pal. Germ. 164).
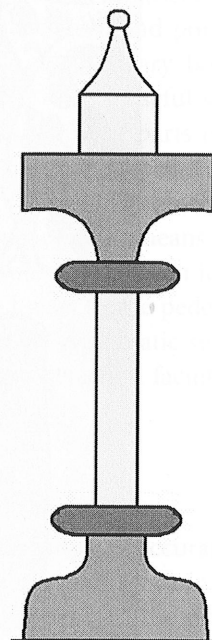
Figure 4 Imaginary fixed reliquary prototype. Image: Peter Bell.

In the first illumination, the plinth and the reliquary box are more elaborate than usual. In the two drawings, the reliquary, which generally accompanies the throne of the judge, is separated from the judge and associated with those who take an oath for or against it. The court usher appears in this particular space in order to take an oath at times for and at other times against the judge. In the first illumination he also seems to prevent the judge's oath. This special staging of the reliquary can be explained by the fact that in these scenes the judge's authority, usually unquestioned and typically emphasized by different attributes of power, has been confronted by a powerful symbol superior to him.[18]

The altered form of the reliquary in these image fields indicates the meaning of the respective law cases, but this explanation does not necessarily apply to all alterations. The sketchiness of the drawings suggests continued variation on an imaginarily fixed prototype (Figure 4). The semantic and contextual changes go along with compositional ones. For example, in one scene in which both the king and his crown as well as the reliquary are being sworn upon, the reliquary is adapted to the dimensions of the crown (29r, 2; III, 88, § 1). This generates a compositional and perhaps semantic counterbalance to the king's oath.

The reliquary and its pedestal interact with their surroundings not only by adjusting their size but also their form. This becomes particularly evident on the foot of the stand in 9v, 2 (Figure 5). Its form, which is taken up in a candelabrum on the following
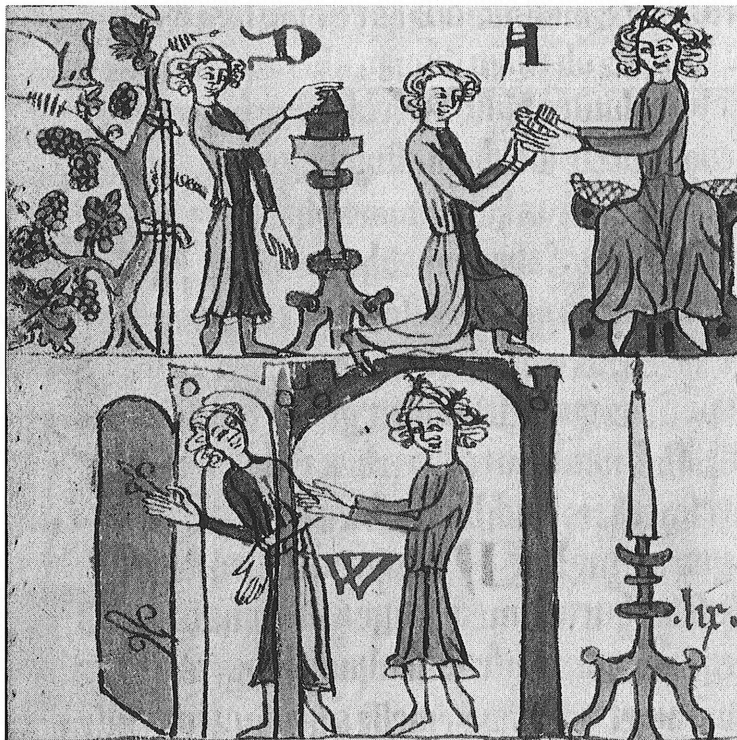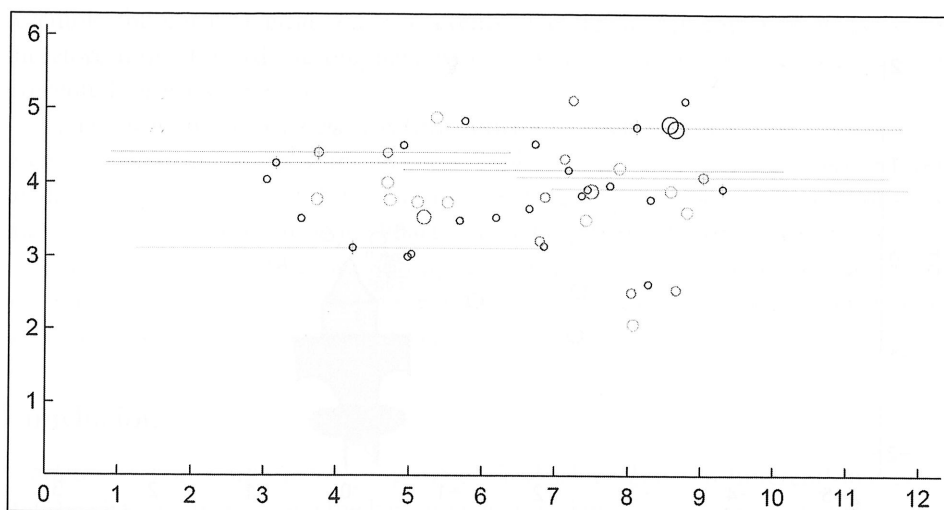

Figure 5   Motif in reliquary stand, imitating vines and branches, repeated in candelabrum below. Detail of f.7v, Heidelberg *Sachsenspiegel* (University Library, MS Cod. Pal. Germ. 164).

Figure 6   The position of the shrine's peak and the representation of every swearing gesture as the center of a circle. The radius and color of the circles are determined by the number of swearing gestures that appear in connection with this reliquary. Chart: Peter Bell and Joseph Schlecht.

illumination, seems to imitate plants and the vine branches next to it.[19] As a result of the relative flexibility of the respective object forms, certain characteristics thus interact beyond a single page.

The heterogeneous composition of the reliquary and the pedestal complicates automatic object retrieval. In the Heidelberg manuscript, standardization, as observed in the gestures, is avoided with objects in favor of compositional freedom and pointed visual statements. At the same time, the depiction of the actual reliquary box is mostly uniform and is detected as *pars pro toto*. This procedure is very useful since some scenes dispense with the pedestal altogether or occlude significant parts of it. The five cases in which the reliquary box is held in the hand can be explained by textual aspects, for example, when the trial takes place outside the law court, or by composition. The uniform shape of the box can be automatically retrieved by means of a predefined model of outlines, as described above. Once these images have been identified, the second step is to ask whether the findings give any clue as to the pedestal, which is typically situated between the reliquary and the base line. Automatic seeing thus becomes part of a gradual process of identification in which detection facilitates hypotheses about the location and possible meanings of other objects.

Visualization of Compositional Relationships

With methods of image processing, digitized illuminations can be compared accurately. Since the computer knows the locations of gestures and objects, researchers can visualize the content of the images easily. For example, the relationship between the swearing gesture and the Heidelberg *Sachsenspiegel* reliquary can be elucidated in two examples. The first table (Figure 6) visualizes the position of the shrine's peak and the representation of every swearing gesture as the center of a circle. The radius and
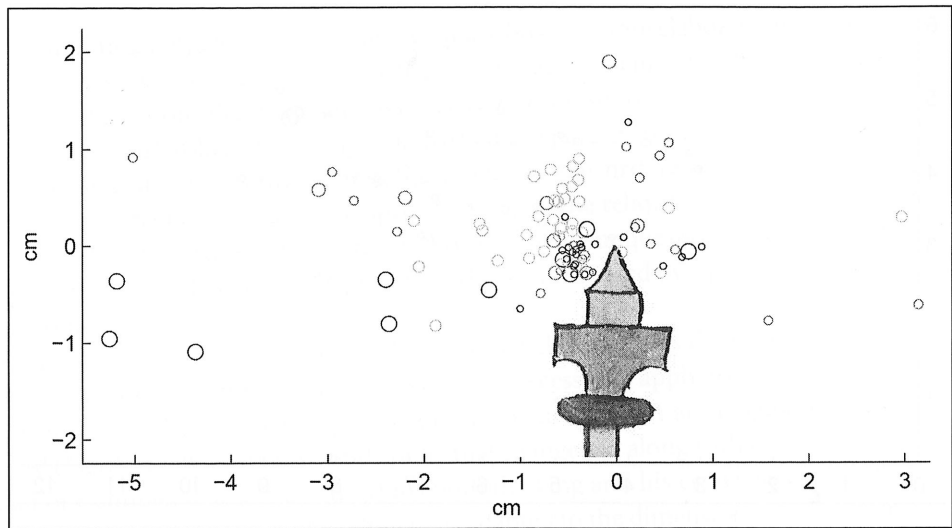
Figure 7 The dispersion of the swearing gestures in relation to the reliquary. All images were centered on the reliquary top (0/0). Chart: Peter Bell and Joseph Schlecht.

color of the circles are determined by the number of swearing gestures that appear in connection with this reliquary. The vertical lines indicate the width of the image fields that do not occupy the entire space of the column. These lines intersect with the circles labeled with the cross, which represents the peak of the reliquary in the respective scene. While the reliquary in these half-width images is generally positioned centrally, the positions in the broader illustrations are more disseminated. However, within these can be found a concentrated subset of images (6.5 and 9.5 on the x-axis) in which the reliquary is positioned to the left of the judge's throne. The reliquary is removed from this position only for compositional and mostly context-related reasons, for example, when the judge abandons his habitual position on the right margin, when an oath is taken against him, or when witnesses called by him approach the scene from the right. The table shows how the detected objects can generate further results by means of compositional patterns.

The second table illustration shows the dispersion of the swearing gestures in relation to the reliquary (Figure 7). All images were centered on the reliquary top (0/0). In this way, we achieved invariance with respect to the size and position of the object. Only the position of the gestures in relation to this benchmark is visualized, and the center of the circles corresponds to the center of the gesture, which is situated on the palm. This analysis illustrates how often the swearers approach the scene from the left and directly touch the box. As one would expect, this is primarily undertaken by individuals, while groups join their hands at one point or line up one after the other in order to present themselves individually. Swearing gestures that appear at a large distance above the reliquary mostly represent hands that are prevented from swearing. In some areas the composition requires a space between the reliquary and the individuals ready to swear, e.g., when the dead judge's outstretched body prevents a group of witnesses from swearing (15v, 4).[20] In many cases, the different positions of the hands

resemble the chronological order of events. The agents are prepared to swear and therefore move toward the reliquary with a specific gesture, perform the ritual, are prevented, or evoke the act.

The images of the *Sachsenspiegel* are difficult to interpret since their reading always oscillates between visual and juridical explanations. Drawing conclusions about medieval legal practice requires awareness that their dense representations gain momentum via compositional, didactic, and narrative solutions. Even the gestures considered reliable are not always applied consistently and can be changed within the same set of manuscripts. These tendencies indicate a narrative usage of the image instead of a strict sign language.

Conclusion

Computer vision assists us by proposing relationships between different objects and stylistic changes, by enabling the handling of large data volumes, and even by detecting some details more precisely. In the future, archiving, presenting, and searching illuminated manuscripts can be organized more efficiently since a visual recognition-based approach such as ours reduces the dependence on translating image content into text. However, the procedure requires art historical expertise to evaluate and interpret the results. It cannot replace the human eye and has no intention of doing so. If art history wants to develop this instrument further, it has to push forward machine learning and computer vision in the field of art analysis by following the development of visual learning algorithms. The cooperation between both fields can further benefit by selecting significant image datasets that create opportunities for learning and training.

The variability of objects, and the difficulties associated with identifying and interpreting objects, eloquently illustrates medieval points of view and compositional skills. Computer-aided detection reveals that the illustrator adapts regalia to the textual and compositional demands of each scene. It also indicates that gestures are applied much more freely than hitherto believed in academic research. The reasons for this can be found in compositional particularities, the delight in variation, and a relatively sloppy drawing style. The highly individual arrangement (rather than a standardized vocabulary of forms) also provides a commentary on the respective scenes, for example, when a reliquary is staged in a particular way or is marginalized. The ever new constellations of objects and gestures point to the inventiveness and narrativity of the law cases.

By means of an automatic learning process, the algorithm can also identify variants. In this way, the partly sloppy drawings of the gestures in the *Sachsenspiegel* or the crowns of the *Codices Palatini germanici* can be reliably identified, whereas the retrieval of less standardized objects, such as the continuously changing pedestal of the reliquary, is more problematic. However, breaking the object down into two basic elements—the relatively static reliquary and the varying pedestal underneath—facilitates the detection.

Computer-based object retrieval and visualizations are suitable for large image datasets with more or less standardized characteristics. To start, machine learning

with a well-documented codex had didactic advantages, but the mathematical procedure can also be applied to similarly complex problems in other categories and to less developed material. In the future, archiving, presentation, and searching can be organized more efficiently since the translation of image contents into text is, in part, no longer necessary.

Acknowledgments

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1   Hiram Kümper, *Sachsenspiegel: Eine Bibliographie—mit einer Einleitung zu Überlieferung, Wirkung und Forschung* (Nordhausen: Traugott Bautz, 2004). The latest facsimiles for the Heidelberg *Sachsenspiegel* are Eike von Repgow, *Vollständige Faksimile—Ausgabe im Originalformat des Heidelberger Sachsenspiegels: Cod. Pal. Germ. 164 der Universitätsbibliothek Heidelberg*, ed. Gernot Kocher (Graz: Akademische Druck- und Verlagsanstalt, 2010); Dietlinde Munzel-Everling, *Der Sachsenspiegel: die Heidelberger Bilderhandschrift; Faksimile, Transkription, Übersetzung, Bildbeschreibung*. CD-ROM (Heidelberg: Universitätsbibliothek, 2009); and Eike von Repgow, "Universitätsbibliothek Heidelberg, Cod. Pal. germ. 164," at http://digi.ub.uni-heidelberg.de/diglit/cpg164/. The manuscript images illustrated in this article can be found in the PDF as follow: Fig. 1, p. 44; Fig. 2, p. 47; Fig. 3, p. 28; Fig. 5, p. 32; and f. 29v (described in the text), p. 71.

2   In particular, for gestures in the *Sachsenspiegel*, see the seminal contributions of Karl von Amira and Ruth Schmidt-Wiegand: Karl von Amira, "Die Handgebärden in den Bilderhandschriften des Sachsenspiegels," *Abhandlungen der Bayerischen Akademie der Wissenschaften, Philosophisch-Philologische und Historische Klasse* 23, no. 2 (1905): 161–264 and online at http://babel.hathitrust.org/cgi/pt?id=mdp.39015039368793;seq=5;view=1up); and Ruth Schmidt-Wiegand, "Gebärdensprache im Recht," *Reallexikon der Germanischen Altertumskunde* 10 (1998): 500–4.

3   The other codices are Dresden, Mscr.Dresd.M.32; Herzog August Bibliothek Wolfenbüttel, Cod. Guelf. 3.1 Aug. 2°; and Landesbibliothek Oldenburg, CIM I 410.

4   Regarding the technical details of image retrieval in the *Sachsenspiegel*, see Joseph Schlecht, Bernd Carqué, Björn Ommer, "Detecting Gestures in Medieval Images," in *2011 18th IEEE International Conference on Image Processing Proceedings*, September 11–14, 2011, Brussels, Belgium, 1285–88.

5   Dagmar Hüpper, "Die Bildersprache: Zur Funktion der Illustration," in *Die Wolfenbütteler Bilderhandschrift des Sachsenspiegels: Aufsätze und Untersuchungen:*

Kommentarband zur Faksimile-Ausgabe, ed. Ruth Schmidt-Wiegand (Berlin: Akademie Verlag, 1993), 143–62.

6   Johannes Fried, "Eike Von Repgow: Sachsenspiegel. Die Wolfenbütteler Bilderhandschrift Cod. Guel. 3.1 Aug. 20," *Historische Zeitschrift* 260, no. 3 (1995): 865–69, 868.

7   Ulrike Lade-Messerschmied, "Die Gebärdensprache in der Wolfenbütteler Bilderhandschrift des Sachsenspiegels," in Schmidt-Wiegand, *Die Wolfenbütteler Bilderhandschrift*, 185. Already Franz Kugler referred to a "grammatically sophisticated language" (transl. Bell) in "Bilderhandschriften des Mittelalters," in *Kleine Schriften und Studien zur Kunstgeschichte: Mit Illustrationen und andern artistischen Beilagen*, vol. 1 (Stuttgart: Von Ebner & Seubert, 1853), 49 and online at http://goobipr2.uni-weimar.de/viewer/image/PPN623234394/19/. The facial expressions are definitely subordinate as compared to the gestures; see Walter Koschorreck and Wilfried Werner, eds., *Der Sachsenspiegel: Die Heidelberger Bilderhandschrift Cod. Pal. Germ. 164. Kommentar und Übersetzung* (Frankfurt am Main: Insel, 1989), 101.

8   "Gut" und "Gewere" can be roughly translated as "good" and "guarantee," in this case to own a piece of land or have rights on it.

9   Koschorrek and Werner, *Der Sachsenspiegel*, 107, characterize the hands as being drawn with "stenciled exactitude," "in sharp contrast to the mostly sketchy drawings of hands busy with minor activities, or resting."

10   The pointer to objects in different positions makes this especially clear. With respect to the swearing gesture, Lade-Messerschmied, "Die Gebärdensprache," 190, supposes a ritual change that can be recognized in the series of manuscripts and develops from the touching of the reliquary to a raised swearing gesture. Independently, the different orientations can also be explained by different moments in the process of the law ritual.

11   See the digitized manuscripts at http://www.ub.uni-heidelberg.de/Englisch/helios/digi/palatina.html.

12   Antonio Monroy, Bernd Carqué, and Björn Ommer, "Reconstructing the Drawing Process of Reproductions from Medieval Images," in *2011 18th IEEE International Conference on Image Processing Proceedings*, September 11–14, 2011, Brussels, Belgium, 2917–20; and Juan Antonio Monroy Kuhn, Peter Bell, and Björn Ommer, "Shaping Art with Art: Morphological Analysis for Investigating Artistic Reproductions," *ECCV European Conference on Computer Vision, Visart Workshop* (2012), 571–80.

13   See the database of the Kunsthistorisches Institut in Florence, Italy, *Stemmario: Coats of Arms of the Florentine Families, Churches, Confraternities and Hospitals* at http://wappen.khi.fi.it; regarding the further application of image processing beyond object retrieval, for example, in the field of low-level vision, see C. Richard Johnson, Jr., Ella Hendriks, Igor J. Berezhnoy, et al., "Image Processing for Artist Identification: Computerized Analysis of Vincent van Gogh's Painting Brushstrokes," at http://infolab.stanford.edu/~wangz/project/imsearch/ART/SP08/sp_vangogh.pdf/.

14   Fig. 1 illustrates the inaccuracies in the swearing gesture. The index finger is hardly visible. It should be noted, however, that there are several swearing gestures which are shown without the reliquary; this happens strikingly often when women, who had no right to swear, are represented, or in scenes where a change of ownership, for example, of clothes or horses, is taking place.

15   Rolf Schäfer, "Christliches Bildungsgut im Oldenburger Sachsenspiegel," in Egbert Koolman, Ewald Gässler, and Friedrich Scheele, eds., *Der sassen speyghel: Sachsenspiegel–Recht–Alltag*, vol. 1 (Oldenburg: Isensee, 1995), 101–2, briefly discusses the

meaning of the relics and identifies in them the court's proximity to the church if not the church as the site of the trials. See also Schmidt-Wiegand, "Gebärdensprache im Recht."

16   The "VI" indicates a time limit of six weeks in which the outlaw has to appear at the royal court. The number seems to bind the outlaw literally to the throne and therefore signifies an obligation.

17   The meaning of the document is yet again underlined by its increased size. The immense power of representation of the seal as a synonym of the presence of the king in front of the judge is expressed by the judge's liveliness. At the moment of trans-action it is figuratively silent. Only in front of the judge does it speak by means of a gesture and transform into an acting representation.

18   The fact that certain situations require a special stand for the reliquary is suggested by the Oldenburg *Sachsenspiegel*, 79v, 1, in which a newly elected king takes his oath on the reliquary carried by griffins. Apart from that, the Oldenburg *Sachsenspiegel* mostly displays simple pedestals which are adjusted to the height of the swearing hand (cf. the similar scenes in Oldenburg 47r, 1/2, in comparison to the Heidelberg example) and are occasionally ornamented by scrolls or leafy ornaments.

19   It is difficult to interpret the vegetal reliquary. This form can probably be explained by the metaphor of growing and matureness, although the form could be inspired uncon-sciously by the nearby plants (cf. III 58, § 3). A similar phenomenon of correspon-dence of forms can be seen in 13r, 1/2, in which the circular forms of the bells on the robe of the *sinelosen* (insane) man probably prompted the circles and curls on the reliquary underneath. In 18r, 4, the unusual circles on the capital correspond to the hand- and foot-fetters of the swearers.

20   Karl von Amira, "Die Handgebärden in den Bilderhandschriften des Sachsenspiegels," 168, points out that the actual swearing had to be carried out at an exact distance to the sanctuary.