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RESEARCH ARTICLE

A Camera-Based Tracking System for Ouija Research

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Abstract—For more than a century, the Ouija phenomenon has been subject to discussions about how planchette motions and resulting messages can be explained, with the majority of scientists considering the *ideomotor effect* as a sufficient explanation. Research on the Ouija board is scarce, even though in principle experiments could be done quite easily. This article presents a technical system and software used to gain detailed data about planchette motions and the sitters' interaction, while at the same time providing spelling support during the Ouija session. It uses camera-based tracking of the planchette and can be complemented by data collected with a sensor placed directly on the planchette. The data is analyzed and evaluated in various ways with regard to the planchette motions as well as the text production. The system has been used in more than 50 Ouija sessions with two to five sitters; example data is provided to show its potential to gain new insights into the Ouija phenomenon.

Introduction

The Ouija board has a history over more than a century as a widely used tool for allegedly communicating with non-physical beings. For some scientists, it is just another example of the ideomotor effect: When in the middle of the 19th century people were enthusiastically "talking to spirits," for example by doing table tipping, scientists were looking for explanations that would fit into the materialistic worldview. Carpenter (1852) proposed that an unconscious *ideomotor* effect explains these phenomena. Tiny muscular motions of the sitters are triggered by thoughts, ideas, suggestions, which the sitters do not even recognize as their own. Together with a feedback loop, this leads to physical, apparently meaningful movements, whether it is a table or a planchette that does the moving; all movements are nothing but an "automated motion" driven by the sitters. More than one and a half centuries later, this point of view is still predominant, as summarized matter-of-factly in *Wikipedia* (2019): "The action of the board can be parsimoniously explained by unconscious movements of those controlling the pointer, a psychophysiological phenomenon known as the ideomotor effect."

That sounds like a long-established fact, and ever since the term *ideomotor response* was coined, the topic seems to be mostly ticked off on scientists' lists. Even though Ouija experiments could be done quite easily, research on it is scarce, often based on somewhat artificial laboratory settings and tasks, without looking deeper into what "ideomotor" actually means, let alone taking potential psi effects into account. But ideomotor action is, at best, only part of the explanation; it addresses how the planchette motions can be explained physically and that a sense of agency is lost. It does not offer insight into the nature of Ouija messages, their potentially surprising complexity, originality, informational content, the relation to the sitters' consciousnesses, and the speed with which messages come through, which can go much beyond what a volitional coordinated action of sitters could achieve.

Just recently, a study on Ouija appeared in the context of psychological research. Andersen et al. (2018) proposed an approach using eye-tracking to relate the planchette motion to the "predictive minds" of the sitters. Whenever the two sitters looked at a letter which was going to be hit, it was considered as evidence that they were causing or somehow "predicting" the planchette motions. While this is an interesting idea, that article has some shortcomings. First of all, it does not mention saccade motions at all: The human eye is constantly scanning the scene, with the gaze quickly fixating on points of interests, e.g., when watching a human face it wanders quickly back and forth between eyes, nose, and mouth. Andersen et al. take the fact that the gaze is directed toward the letter where the planchette is going to move as an indication that some 'prediction' is taking place. But very likely the gaze fixates also on other letters or areas, such that a meaningful criterion needs to consider if the target letter is fixated on for a significantly longer period of time than other letters are. This issue is not mentioned. No information is provided about whether the gaze path includes other letters, how long it remains at other positions, and how this is taken into account to assign the "predicted target letter" a unique role. The analysis of the eye-tracking data (which, surprisingly, was done manually, taking "around one and a half hours for the coders to annotate 1 min of video"), does not even seem to collect the required information. Thus, even if the gaze was continuously scanning the entire alphabet, the approach would count the target letter as being "predicted."

Regarding the content, the experiments were very simple. Only a single word was spelled out in each experiment, of 5 to 11 letters, and apparently it was quite a slow process (no exact data about duration was provided, but the sessions lasted about 10 minutes). For comparison with volitional actions, the single word BALTIMORE had to be jointly spelled by the two sitters. The fact that the predefined response was required for the volitional experiments points to an important question: Why is it apparently not possible to replicate the Ouija communication by conscious, voluntary actions, i.e. by jointly spelling meaningful responses, which were not agreed upon before; what needs to be added, unconsciously or by non-normal means of information retrieval?

Anderson's approach is focused on the physical actions of the sitters, the fact that their sensorimotor system is involved in the action, and that the sitters typically deny authorship of their actions. Key terms are the *ideomotor effect*, and a good overview is provided by Stock and Stock (2004); and loss of *sense of agency*, a misattribution of actions that depends on the individual (de Bézenac et al. 2015) and is an indicator of personality traits such as sensitivity to subtle stimuli (Olson, Jeyanesan, & Raz 2017) which can also be used in hypnosis and hypnoanalysis (Shenefelt 2011).

Research that takes a closer look at the content of the communication is hard to find. A publication that stands out in that respect is Gauchou, Rensink, and Fels (2012). People who did a test with a single participant had to answer yes–no questions with the Ouija board, while the second sitter was a confederate of the research team who withdrew his finger from the planchette, unnoticed by the test person who was blindfolded. The authors conclude that the results "suggest that nonconscious knowledge can indeed be expressed through ideomotor actions, even when it cannot be accessed consciously." The possibility of non-normal access to information beyond what is hidden in the unconsious was not taken into consideration. Regarding the exploration of the full potential of Ouija communication, it would probably have been a poor setting anyway: All 27 study participants had never "played" Ouija before, and the authors stated that "response times for Ouija can sometimes require several minutes," i.e. processes were quite slow. Only yes–no questions were to be answered without emotional or personal content (such as "Is Brasilia the capital of Argentina?").

While Ouija is rarely addressed directly in publications, there is a more intense scientific discussion about *facilitated communication* (Mazerolle & Legosz 2012). This technique aims at supporting people who have limited communication skills due to disabilities. According to a given protocol, the so-called facilitator holds the hand of the client and thus helps him type letters on a keyboard. The proponents of this method claim that the resulting texts are an expression of the client and the facilitator is just helping but not contributing to the content. Critics counter with arguments such that the resulting texts contain information only known to the facilitator (Schlosser et al. 2014).

A look into this technique and the controversy around it is instructive also with regard to Ouija. If one accepts the spiritist interpretation of Ouija board activity, the sitters at the Ouija board can be regarded as facilitators who help the ‘spirit world’ to bring through its messages. In both cases, the facilitators or sitters have the impression they are only following external impulses. There are similar ways of reasoning and finding evidence for or against the assumption that the communication goes beyond what the facilitators or sitters could absorb. For example, Biklen, Saha, and Kliewer (1995) list various criteria for how facilitators recognize the true authorship of their clients, such as “How Students Attend to Typing,” “Communication Form, Content, and Style,” “Spelling and Word Formations,” and “Conveying Accurate Information Not Known to the Facilitator.” All these can also be valuable for Ouija.

Facilitated communication is still subject to an ongoing scientific discussion. Saloviita (2016) even complains that recent publications mostly favor facilitated communication as a valid technique to actually communicate with the client. A typical approach from the critic’s perspective is to show that the information brought through depends mostly on what the facilitators already knew. For example, Burgess et al. (1998) provided the facilitators with fictitious information about the subject, who was impersonated by a confederate of the research team and was someone without disabilities. The fact that this information later showed up during the communication (and other information did not) was regarded as evidence against facilitated communication.

This paper proposes methods to gain further insight into the Ouija board phenomenon and ideomotor action, based on precise measurements during the sitters’ interaction with the planchette. The technical setup is presented in the next section. There are various ways to analyze the collected data; these are presented in the Results, Data, and Analyses section, which provides examples of the data collected in numerous Ouija sessions. The conclusions follow that in the Discussion section.

Materials and Methods

Measurement Techniques

My idea to bring in some technical devices to Ouija sessions was initially triggered by mere convenience. In the course of regular sessions, writing down letters on paper was tedious and often not fast enough. So I switched over to speech recognition. Just saying the letters using the German spelling

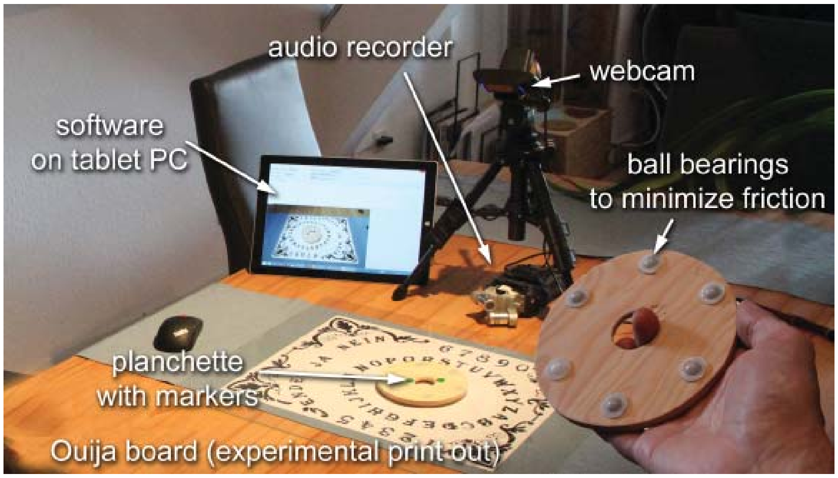

Figure 1. Experimental setup.

alphabet (analogous to Alfa, Bravo, Charlie) was quite a step forward, but still prone to errors, when speech recognition picked up questions or voices from other sitters. So, finally I developed a setup that allows complete tracking and spelling support in real time during the Ouija session.

Figure 1 gives an overview of the setup. A webcam (Logitech C920, in 720p mode) on a tripod is used to monitor the Ouija board. The planchette has two, colored, circular markers attached, which are detected by an image-processing algorithm: For the pixels of each frame coming from the camera, the distance to the (previously configured) marker color is calculated in HSL color space. Thus, binary image information is obtained, which is segmented into coherent blobs. Due to noise and depending on lighting conditions, sometimes single pixels outside the marker area are detected, but by simply taking the two largest blobs the marker areas are reliably detected.

The segment centroids are calculated in the image-coordinate system and then transformed into the coordinate system of the Ouija board using the camera parameters and relative coordinates with respect to the Ouija board. The required camera calibration is done before the session, once the board and camera have been put in place. The procedure is done automatically, typically in less than a minute, by comparing a previously stored image of the board with the incoming camera images. Starting with some default camera calibration data, the stored image is transformed into image coordinates and the difference from the incoming images is calculated. A stochastic gradient descent is done until a precise match is obtained, which can be visually checked by the user.

The markers are typically captured with an accuracy of about 1 millimeter, resulting in a similar accuracy for the position data and orientation accuracy of 2 degrees. Poor lighting conditions or high planchette velocities causing motion blur can degrade accuracy.

Letter Detection and Text Generation

The positional data of the planchette is used for real-time detection of letters during the session. For each letter, activation areas are defined, basically matching the enclosure of the symbol on the board. For yes, no, and end fields, activation areas are signifantly larger. Initially, the algorithm and its parameters needed to be refined and tuned to cope with the variety of ways the planchette is moved in different circumstances and with different sitters. For example, if the planchette slowly passes over the letters without stopping, they should not be counted as hits. On the other hand, simply requiring the planchette to stop at a letter does not work with faster spelling where the planchette immediately continues its motion in a different direction after touching a letter. Thus, both criteria are combined to register a hit. Either the planchette comes to a complete stop at least for a fraction of a second (set to 150 ms) or it abruptly changes its direction of motion with a sharp angle (smaller than 90 degrees). Before the same letter can be registered a second time, the planchette needs to move away from it. The duration, angle, and other parameters can be fine-tuned in the software code. But after initial experiments, there was no need for further adjustments, as the system performed well with different circumstances and sitters.

When a letter or symbol is registered, it is added to the protocol and an equivalent voice sample is played as feedback for the sitters. With each letter being added to the text, a dictionary (German or English) is employed to automatically identify words and insert spaces (which are not marked on the Ouija board) into the stream of letters to improve readability. Occasionally, a later manual correction may be required when there are more options of how letters can be grouped into words or if a word is not part of the dictionary or is misspelled. The motion data and the assigned letters are stored in a text file for later analysis. The system also includes the orientation of the planchette, which is not relevant for letter detection but is of interest for further analyses.

Recording a Session

In order to capture the questions and discussions of the sitters, a digital audio recorder is used to record the entire session. After the session, the software can import the audio file and align it time-synchronously with the other

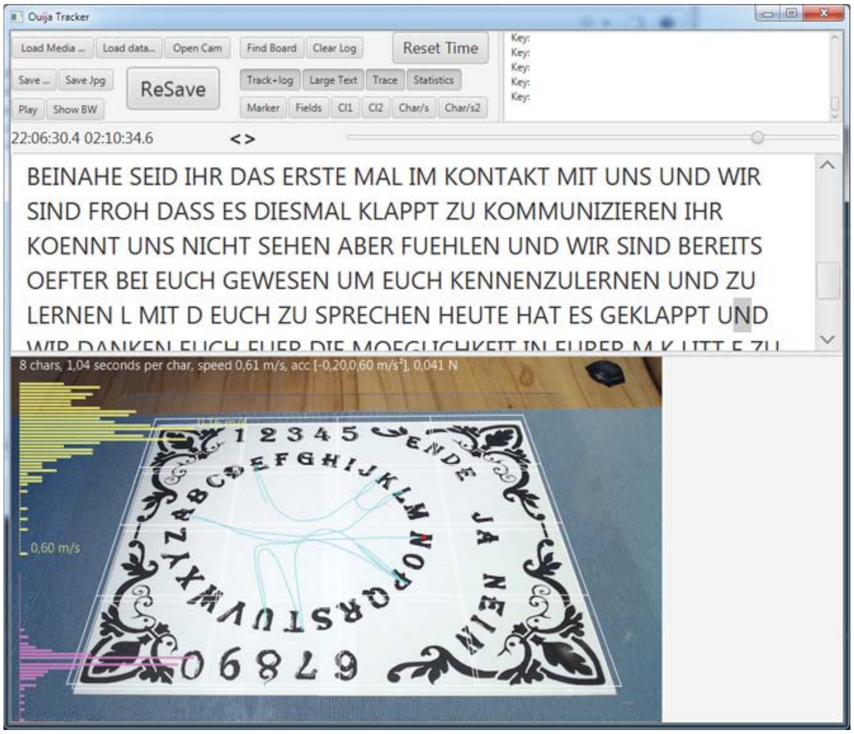

Figure 2. Screenshot of Software Used.

data of the session, such that sitters' questions, planchette motions, and the resulting text can be investigated together with precise timing information. Timer resolution is 30 Hz, based on the frame rate of the webcam (with some minimally varying lag for image processing). From the motion data, statistical analyses and graphical representations can be generated. All this is handled by software written in the Java programming language (Figure 2). The software also supports the display and integration of a session recorded on video, instead of using life data from the camera. In that case, tracking, spelling, and data evaluation can be done completely offline.

As reference and for those interested in the details of the image processing and other algorithms, the Java source code is accessible for download via the Open Science Framework (Kruse 2019). Thus, anybody with Java programming skills can validate the methods used above, including parameters and calculation details. It should be noted, however,`3.6 that the source code is not in a product-quality state. Internal

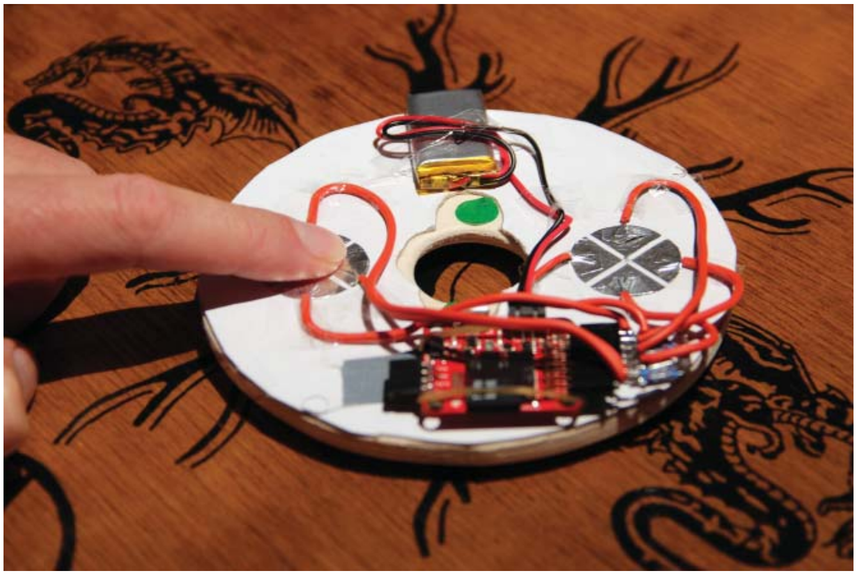

Figure 3. Planchette with additional sensors.

technical documentation is limited (as there were no other programmers involved), there is no user documentation, and the setup for an arbitrary Ouija board needs some preparatory configuration steps.

It is not within the scope of this work to provide a ready-to-use product. To build and run the program, a third-party library for webcam access is required, as well as a dictionary file, an audio file containing speech samples of the alphabet, and additional Ouija fields. A photo of the Ouija board being used needs to be prepared using a photo editing application as reference for camera calibration and definition of active areas. As these external files are subject to copyrights I do not own, they are not included in the download package.

Planchette Sensors

In addition to the above setup, a sensing device can be placed directly on the planchette (Figure 3), with a LiPo battery as power supply and a microSD card for local storage. A motion sensor (MPU-9250, InvenSense) measures acceleration, gyroscope, and magnetic compass data, each along three axes. In addition, self-made capacitive sensors were attached to the planchette, which are sensitive to touch and the pressure of fingers, as the dielectric property of a human finger changes the electrical capacity of the

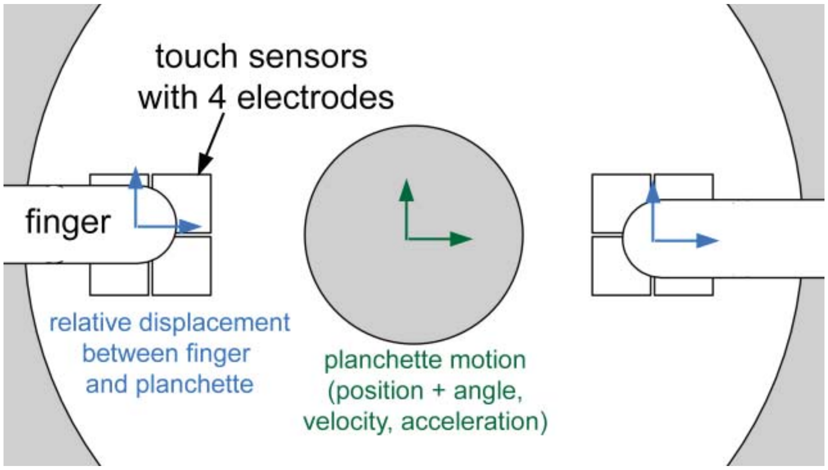

Figure 4. Principle of capacitive sensors.

electrodes. The technical setup is straightforward: Each electrode, a piece of tinfoil, is connected to a digital input pin of the board, which in addition is connected via a high Ohm resistor (2 MΩ, but others work as well) to a common digital output pin, which sends a digital pulsing signal. The RC-circuits (with C being the capacity of the electrodes) produce slight delays until the signal is detected by the corresponding input pin. The delay is a direct measure of the capacity, i.e. of the distance and/or contact area of the dieletric human body to the electrode. For simplicity in coding, Badger's Capacitive Sensing Library (Badger 2019) has been used. Readings are done with 50 Hz frequency.

Experiments have been carried out with different layouts, with two or four electrodes for each sensor, thus capturing small displacements of the sitters' finger along one or two axes (Figure 4). Typically, recommended improvements for the stability of touch sensors, such as adding a small capacitor between the input pin and ground, were not applied, as absolute real-time values are of no interest and the data can be processed and evaluated later offline. In our case the change in capacity, namely the simultaneous increase in one electrode and decrease at the opposite electrode, is the most significant value, as it indicates a (potentially even very small) displacement of the finger on the planchette. The raw data is stored in plain text files with time stamps, similar to the Ouija data format.

In addition, some preliminary experiments with myoelectric sensors (MyoWare Muscle Sensor from Sparkfun) have been done. They can capture the electric potential and thus the contraction of the sitters' forearm muscles. When time-synchronized with the other data about planchette motions, they could potentially provide further insight into how the actual planchette motions (camera-based tracking), finger-planchette interaction (touch sensor), and the arm motions (myo-sensors) are related. However, to get reliable, meaningful signals from the MyoWare sensor turned out to require much more effort and/or better myoelectric sensors. Consequently, the measurement of the direct interaction of fingertips with the planchette so far seems to be the more promising path.

Results, Data, and Analyses

The presented measurement setup yields extensive data which can be analyzed in various ways. This section presents some of the collected data as an example and shows how different types of analyses may provide new insights into the Ouija phenomenon.

So far, this system has been used in more than 50 Ouija sessions. All of these have been 'real-life' sessions, with personal questions and answers, emotional content, and real interest from the sitters in the communication. The system was considered only as support and for collecting data, no specific research experiments were set up, the communication was an unstructured dialogue, where all sitters were allowed to ask questions. Most of the sessions were with two sitters (the author and his wife), one with three sitters, eleven with four sitters, and four with five sitters. In total, 16 different people participated in the sessions, with different backgrounds, including one person without any prior Ouija experience and two persons working professionally as mediums. Four sessions were done with native English speakers, using an English dictionary, with the whole of those sessions conducted in English.

As the communications were generally very personal, the resulting database is not intended to be published. Example excerpts of the data are available through the Open Science Framework (Kruse 2019): The text files contain a few lines of calibration data followed by motion data with one entry per line: Time code, planchette position x[cm], y[cm], rotation[degree], centroid of image coordinates, target area, detected letter. The raw data can be visualized and replayed as video (for an example see Kruse 2019).

Paths, Speed, and Spelling

The software allows precise measurements of the position and rotation of the planchette, thus the speed, acceleration, and forces required to accelerate the planchette mass also can be calculated. Figure 5 shows an example

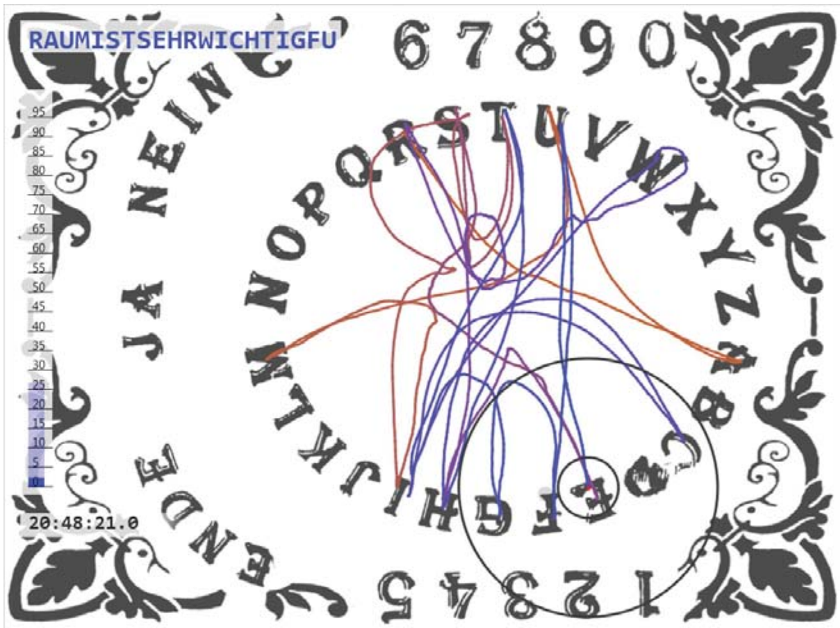

Figure 5. Planchette motions.

of the planchette path during one minute in the middle of a session. Twenty characters were spelled, on average one character every 3 seconds; the average planchette speed was 6 cm/s, maximum speed 30 cm/s, and maximum acceleration 23 cm/s^{2}.

The time needed for spelling a letter also is an interesting metric to describe over the course of a Ouija session. As an example, Figure 6 shows the characters per minute along the session timeline. The thick curve is the average of ten sessions, the thin curves show single sessions. Intervals when the sitters were asking questions were removed from the data. Note that it typically took about half an hour until full speed was reached. The varying individual curves show that in the course of a session there are phases when the spelling slows down or even stops for a while. This happened in the middle of a sentence or within a word, even when the next letter could have been guessed easily. On the other hand, the speed was often high when it was completely open what the next letter might be, such as at the beginning of new phrases.

With some minor manual effort, the percentage of 'wrong' letters that do not fit into correctly spelled phrases can be determined as an additional

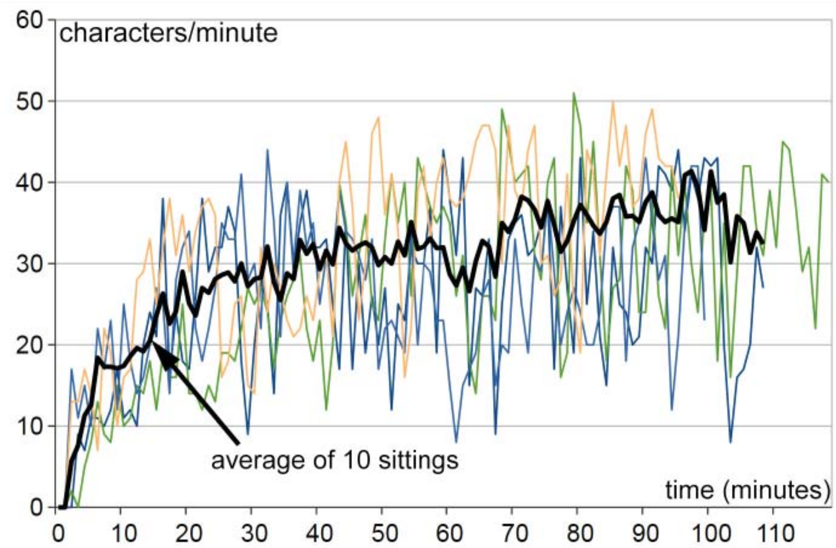

Figure 6. Spelling speed in the course of a session.

metric for spelling accuracy. Throughout the course of the recorded Ouija sessions, a development toward faster and more accurate spelling was observed. Initially, letters were frequently jumbled, focus was on yes–no answers, and total text output was limited to a few hundred characters, often with meaningless phrases. In later sessions, jumbled letters or errors of orthography were rare (typically less than one percent of the spelled characters), and total output increased. For example, a session on 2018/12/30 lasted 2 hours and 10 minutes, and yielded 4,799 characters, on average a character every 1.75 seconds. Due to pauses for questions at the beginning and end of a session, actual spelling was faster, about 1.3 to 1.5 seconds per character. Maximum speed was about 100 cm/s, with almost one character per second.

This data should give an example of how such metrics could contribute to measure and compare the dynamics of Ouija sessions, both along the course of a single session, as well as how they develop over time, for example in a regular circle of practitioners. The data also challenge prevailing assumptions regarding the ideomotor effect, such as Andersen et al.'s (2018) statement "that meaningful responses from the Ouija board may be an emergent property of interacting and predicting minds that increasingly impose structure on initially random events in Ouija sessions." If that was the case, one should expect that once "structure" is established, i.e. a

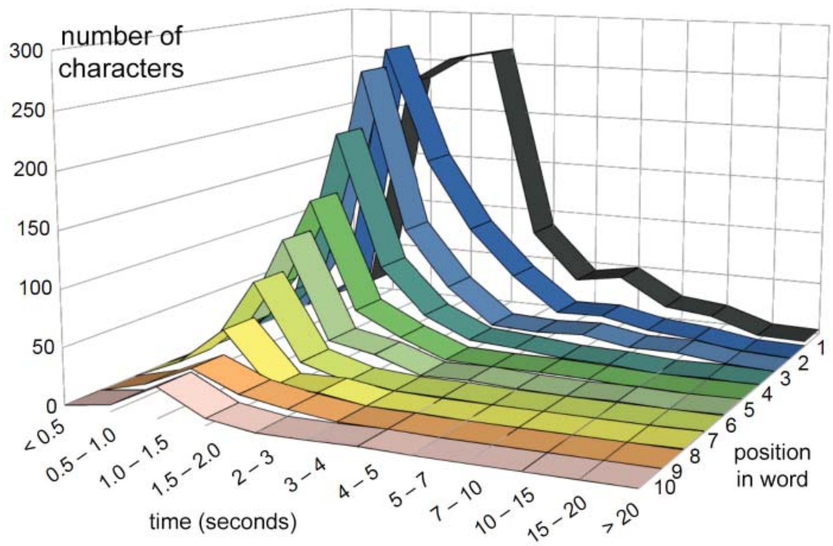

Figure 7. Histogram regarding character duration and position in word.

meaningful beginning of a word or sentence, the spelling becomes easier and quicker. Sometimes this was the case in our data, but in general there was no correlation between spelling speed and the number of meaningful letter choices, or, in other terms, the ease with which the next letter could have been guessed. Also, sessions typically started right away with clear and meaningful sentences, which do not at all appear like initial random events that are only gradually molded into German phrases.

To elaborate on this, Figure 7 shows a histogram of how the time for spelling a character depends on its position in the word (according to the subsequent grouping of characters to correct German words; data are from a session on 2018/10/28, total 3,434 characters). The x-axis represents the duration for spelling a character. The dark curve in the back shows the duration distribution of the first letter of a word, i.e. when there is typically a large choice of potential letters for starting a new word such that it would be much harder to guess or somehow (consciously or unconsciously) agree among the sitters on what letter to choose. The second to tenth letter positions are arranged from back to front, with increasingly brighter curves. After spelling several letters in a word, typically there are few options left for meaningful remaining letters. As the bigger letter positions are relevant only in longer words, the absolute values get smaller from back to front. Generally, there is a strong peak in the histogram for a duration from 1.0 to 1.5 seconds, mostly independent of the position within the word. The first letter might take longer

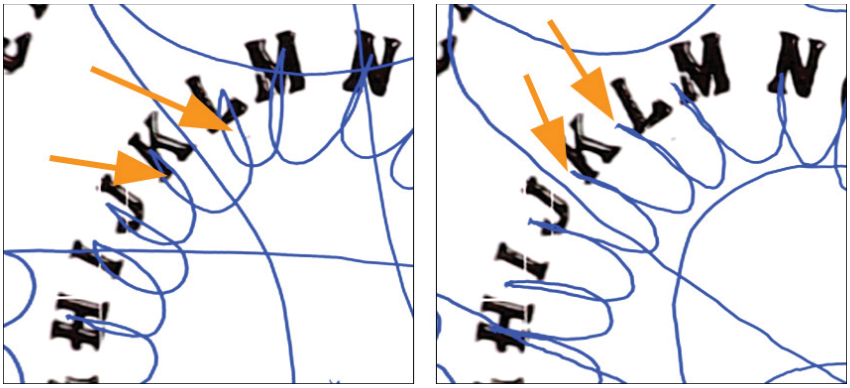

Figure 8. Left: volitional motions. Right: unconscious motions.

(in most cases still less than three seconds), but it is often spelled as fast as the subsequent letters in a word which offers much less choice.

Motion Analysis

The planchette motion data offers some hints regarding sitter interaction and the differences between volitional and unconscious motions. As a regular custom, at the beginning of each session the planchette was moved by the sitters with volitional motions to all the characters on the board. A section of such a path is shown on the left of Figure 8. With this type of motion, the sitters already know the next letters to come, a fact that sometimes shows up in a swinging motion of the planchette, as the next target is already anticipated and the motion is optimized accordingly, resulting in smooth loops along the path (indicated by the arrows).

During unconscious Ouija movements, such effects do not seem to occur. The right side of the figure shows a situation when during a Ouija communication—as a surprise to the two sitters—the complete alphabet was spelled. Even though after some letters it seemed likely that the alphabet was about to be spelled, the sitters tried to remain open-minded, without anticipating anything. Thus, after touching each letter, the next motion starts anew, without any preceding preparatory momentum. Maybe this is a characteristic of 'real' Ouija motions: At any point in time, the motion is (if at all) directed only toward the next letter to be reached, without preparation or motion optimization for spelling the letters to come. This effect needs to be further investigated under various conditions, i.e. with different sitters and more complex volitional spelling tasks for comparison. Maybe it is even

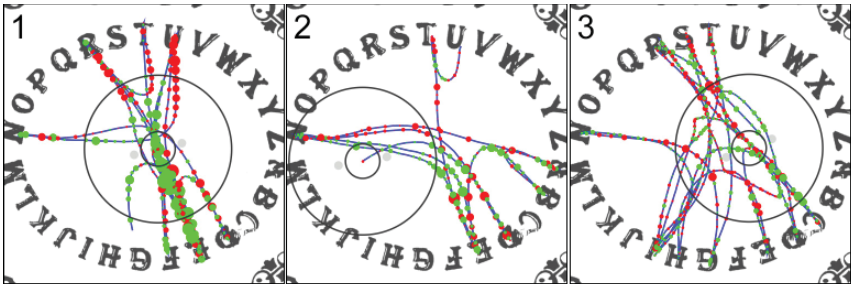

Figure 9. Planchette rotations for different conditions (see text).

possible to derive some mathematical properties of movement paths, such as continuous differentiability and cusps to find a metric which eventually might help to distinguish between volitional and unconscious motions.

Also, the small rotational movements of the planchette, even though not required for letter detection, offer interesting information. When the sitters are moving their hands with slightly different speed or direction, typically a turn of the planchette results. With two sitters sitting face to face, the effect is strongest for motions to the left or right, while backward/forward motions are less likely to cause a rotation. This is based on the observation that with single fingers touching the respective side of the planchette not too firmly, each sitter mostly exerts a translational force on the respective contact point on the planchette, without being able to exert significant torque. Thus, the angular motion of the planchette can be an indication that sitters are not acting synchronously, that one is moving his hand faster or earlier, while the other is dragging behind or reacting with some delay.

Figure 9 illustrates how the rotation varies, with angular velocity being represented by the size of the circles, green for clockwise, red for counterclockwise rotation. The two sitters were to the right and left of the board. Cases 1 and 2 were done as experiments with volitional motions, Case 3 was part of a normal Ouija session (all done on 2019/01/13 under equal conditions, the experiment being performed directly after the Ouija session):

Case 1. A volitional motion was made, with one sitter forcing the planchette to spell a message unknown to the other sitter, who just followed the planchette motions. Strong rotational motions resulted.

Case 2. In this volitional motion, both sitters spelled a text agreed upon by both beforehand. The action is much more synchronous.

Case 3. This is the case of Ouija movement where both sitters have no conscious knowledge about what is going to be spelled. The degree of rotation is similar to Case 2.

It can be seen that during volitional motions, when one person is taking the lead, the other is following with some delay (and sometimes considerable difficulty) required for reacting. In contrast, ideal Ouija motions seem to show much less rotation, the sitters are acting rather synchronously, as if they have the same stimulus or target, which in contrast to Case 2, is unknown to them and was not defined in advance. This observation challenges the ideomotor hypothesis, which seems to require some (unconscious) negotiation process between the sitters, and would probably cause asynchronous motions similar to Case 1. Even if sitters are frequently changing their roles of who is acting and who is reacting, this would show up in the paths.

Blind Ouija?

With the experimental setup of automatic tracking, in principle the whole Ouija process can be done with all sitters closing their eyes while interacting with the planchette. Of course, kinesthetic perception is still available, which was sufficient for blindfolded experiments in Gauchou, Rensink, & Fels (2012) when the planchette only had to be moved to the left or right side of the board to hit yes or no. In our case, when all sitters closed their eyes, spelling quickly came to a stop. When some of the sitters temporarily closed their eyes or looked away from the board, while at least one was still watching, communication usually continued, but could slow down. Apparently, some hand–eye coordination is required for Ouija, to do precise positioning and spelling. This is another field for more systematic research which could easily be done with the system, including precise measurements of how the motion paths are affected.

A somewhat related aspect was observed, when during a session (with four sitters) after a question no letters were spelled but the planchette made a swift motion which at first did not convey any meaning to the sitters. After it was repeated two more times, one of the sitters suggested it could be a heart, which the Ouija communication confirmed with yes. After later analyzing the motion trace (during the session it was switched off), the heart was clearly visible with amazing accuracy (Figure 10). This effect indicates that it is possible that the planchette moves in ways for which the meaning is unveiled only after a later analysis. From the perspective of ideomotor theory this puts another burden to be performed by the unconscious minds of the sitters.

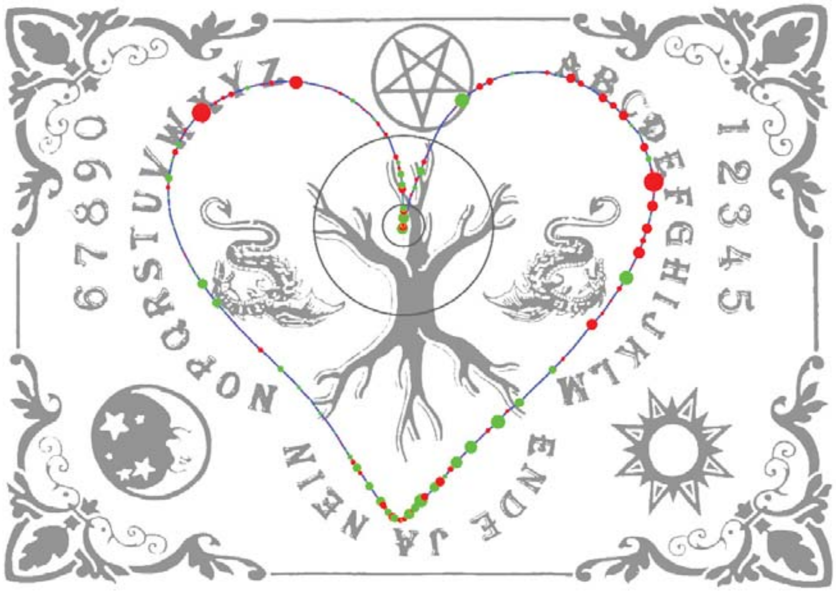

Figure 10. Planchette trace (duration 7 seconds).

Touch Sensors

So far, the touch sensors have been used in just a few sessions, with the current version only working for two sitters. Both sitters have to place one finger in the middle of the sensor field. Results show that with this setup it is possible to have a fine-grained view of the interactions of the sitters and planchette. For example, Figure 11 shows that a slight displacement of the sitter's finger precedes the planchette acceleration, thus supporting the assumption that the planchette is actually moved by the sitters. If the planchette would move by itself and the sitters just follow, it would be vice versa; the planchette motion would result in a displacement of the fingertip in the opposite direction, until the sitter reacts and moves his finger to follow the planchette.

Similar to the analysis of the planchette rotation, the touch data could also be used to identify the precise timing and possible delay with which the sitters are interacting with the planchette. In contrast to the visual tracking of the planchette, currently the data produced by the touch sensor is much more prone to other unwanted influences on the readings. Especially the need to precisely put just one finger on the center of the sensor field caused some stress for the sitters, distracting from the normal flow of the Ouija

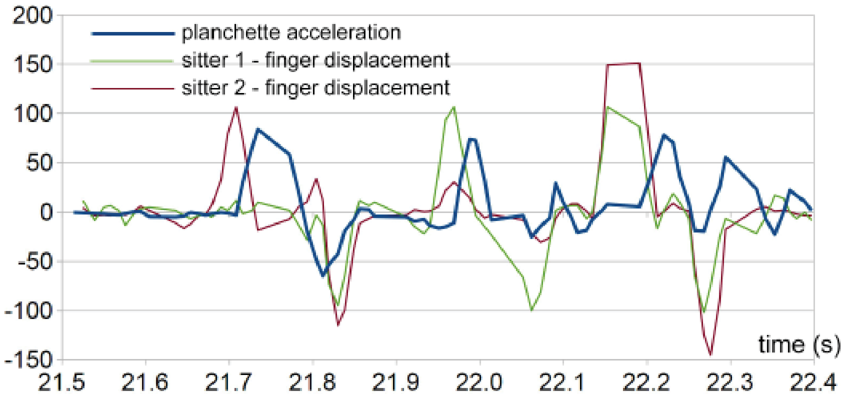

Figure 11. Data from the planchette sensor.

session. Changes of finger positions caused different sensor readings such that an automated, statistical evaluation of the data over longer periods of time was not yet feasible.

Linguistic Analysis

As stated in the Introduction, the sparse research on Ouija is based on experiments where very limited content is communicated. Gauchou, Rensink, and Fels (2012) address only yes–no questions, Andersen et al. (2018) have single words spelled. Also, the speed of the communication was slow in comparison to the quick spelling in our experiments, which leaves much less room for the conscious minds of the sitters to interfere.

The system presented here allows us to easily build up a database of texts produced during Ouija sessions and to use them for further analysis. The textual data collected so far comprises about 220,000 characters (more than 42,000 words), including the precise timing of the spelling of each character. Thus it is tempting to apply linguistic analysis such as is used in forensic scenarios with the goal of authorship attribution (e.g., Kredens & Coulthard 2012). Can lexis, grammar, and semantics provide clues about the identity of the author? This question is also relevant for facilitated communication, because it is confronted with the criticism that it is the facilitator, not the client, who is the source of the typed messages. Biklen et al. (1991) and Niemi and Kärnä-Lin (2002) use linguistic analysis to argue for the validity of facilitated communication. Bernardi (2009) employ statistical text analysis with quantitative measures such as lexical richness.

The software presented here provides a good basis to apply such approaches, in combination with other tools such as AntConc (Anthony 2018), to the Ouija scenario. For example, a corpus analysis was done to describe what words are used and with what frequency. It gives an impression of the typical content and style of communication, but so far does not offer any hard evidence with regard to authorship attribution. Hopefully, with well-designed experiments such as specific protocols and participant selection, linguistic analyses may provide additional insight into the Ouija phenomenon.

Discussion

This article presented a technical system for performing various measurements during Ouija sessions and presented example data. There are various ways these data can be analyzed, offering some new insight into the phenomenon. The system worked reliably throughout most of the sessions, especially after some adaptations were made in early sessions to improve the robustness of image processing and letter recognition. The decision whether a letter is being registered as a hit is always made by the software following identical rules, thus avoiding subjective discussions about whether a letter was part of a message or not. Some minor problems occurred when the system was used in different light conditions, causing single outliers in the readings of the planchette positions and in rare cases requiring manual adjustment of the HSL-color search range during the session. Sitters, especially those who were using the system for the first time, occasionally covered the colored markers of the planchette with their fingers, causing wrong readings until being reminded to keep the markers visible. To deal with that problem, a different version of the planchette was built where the markers are placed three centimeters above the surface of the planchette (held by nails).

All the presented data has been collected in real-life Ouija sessions. On the one hand, this has the advantage of having a realistic scenario to test the system in practice, with engaged test persons, most of them with considerable Ouija experience, and with personal and emotional content in the communication in which the sitters have real interest. Presumably as a consequence, spelling speed, accuracy, and overall quantity and complexity of content surpass the output of more controlled experiments, such as mentioned in the Introduction, by orders of magnitude. On the other hand, controlled experiments with a careful selection of participants and predefined tasks or test questions offer the potential to thoroughly look for correlations between the specific situation and the data captured by the presented system.

While there is still potential for improving the measurements and evaluation, the current analyses show some results that hopefully contribute to more comprehensive explanations of the Ouija phenomenon beyond the ideomotor effect:

• When hitting a letter, details of the motion path (cusps vs. smooth curves) could indicate whether the next letter is already anticipated, hinting at (conscious or unconscious) knowledge of how the spelling will proceed.

• The time needed to spell the next letter was only weakly related to its "guessability," i.e. the number of choices to construct meaningful words, in contrast to Andersen et al.'s (2018) statement about imposing "structure on initially random events."

• According to the experiments with the touch sensor, it is the sitters' fingers that are moving first, then the planchette follows. This complies with the ideomotor explanation. If there were psychokinetic effects, it seems likely that it would be the other way around and the fingers would be following the actions of the planchette.

• Often two sitters were able to move the planchette synchronously, similar to the volitional spelling of a given message. This challenges conventional ideomotor explanations, as these would require some negotiation process regarding the next, unknown target. Even though this might happen unconsciously, it would require some time for information transmission between the sitters and potentially some delay in the action of one sitter, causing similar rotations as when one sitter voluntarily leads the planchette—unless there are psi effects explaining the synchronicity.

The data presented here focused on the planchette motion. Of course, spelling and text content also are of interest, as mentioned with respect to linguistic analysis. In addition, there are various ideas for further improvement of the technical setup. For example, to improve the reliability and ease-of-use of the touch sensor on the planchette, the tinfoil electrodes should be replaced with PCB boards with a fine-grained zigzag pattern. Regarding the evaluation of the motion paths, more elaborate metrics could be calculated such as path smoothness or intensity of rotational movements to find measures that eventually may describe the overall quality of the interaction with the planchette and peculiarities of spelling.

Obviously, the above results should be further investigated and checked if they can be replicated with other sitters under different conditions, potentially also in the context of more controlled experiments. I am considering refining my software such that it can be given away to other interested researchers and/or Ouija circles to do their own experiments.

Basically a webcam, a PC, and colored dots on the planchette are sufficient. It would be great if other groups recorded their sessions in a similar way and results could be compared. However, there are still some obstacles: Currently, the use of the software is somewhat complicated, especially setting it up with different boards requires manual work. Also, I have not written any user documentation. Alternatively, the software could also do an offline analysis of Ouija sessions recorded on video, but then the live feedback of letter detection would be lacking and Ouija circles would probably not want to share their recordings containing personal information. If there is real interest, I am sure we can find a way to jointly benefit from the system to gather more insight into Ouija workings. In any case, I hope this article stimulates the discussion about Ouija research, a subject that is, even after more than a century, still worth exploring further.

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