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Characterization of tea whisking by Japanese Tea Ceremony Performers

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All humans comprehend that actions like walking, dancing, and playing a musical instrument are based on skill. These skill differences are not trivial, and therefore need to be addressed properly. In this research we address the action of whisking tea of Japanese Tea Ceremony practitioners. *Chado* relies in teaching by example and learning by mimicking. Furthermore, since its guidelines and rules are decided by one grand master and are not encouraged to be written, it leads to the performers learning mainly on the tacit knowledge domain. It can then be said that all Tea Ceremony practitioners have a common goal and example to imitate. Several research has been done about Tea Ceremony in a wide range of fields such as aesthetics, sociology, religion, and anthropology. Nevertheless, the characteristics of the physical action of the practitioners has not been well documented. To find the characteristics of one of the basic actions, we analyze data taken from 7 subjects. The subjects are divided into Master, Intermediate, and Novice. Furthermore, they can be divided in schools they come from.

Using a motion caption arrangement of eight optical cameras and a video camera for data processing, subjects were asked to produce a bowl of tea while being recorded. The tea bowl and the whisk were the same and each subject had the final say on the amount of matcha powder and boiling water they wanted to use for each bowl. They repeated this action three times. The model used for the position of the markers and the joint angle analysis was the Plug-in Gait model provided by VICON.

A descriptive statistical analysis of the upper body markers showed that only the right arm moved in an amount significantly different from zero. As for the other sections of the body, the standard deviation was always 1 mm or lower, and thus representing no contribution to the action of whisking.

The time series for the positions of the RFIN marker, which lies just above the end of the whisk on the hand of the subjects, was analyzed in the three different coordinate axis. Novices presented erratic movement and no particular pattern when seen in different planes, especially on the horizontal plane. Masters, on the other hand, showed a distinctive line that can be considered as a path or track that they follow while preparing tea. While some of the experienced practitioners deviated at times from their path, they always returned inside a small frame of time, which cannot be said of the unexperienced ones. The autocorrelation function of the time series of position of the RFIN marker in each axis showed that experienced practitioners have a constant frequency in their motions, something that cannot be said about the novices.

A second type of analysis was conducted on the behavior of the joint angles of the right arm. Out of the seven possible degrees of freedom, the shoulder flexion/extension angle had to be disregarded as it varied little or nothing when compared to the other six. A phase comparison was carried out with the three wrist angles, the elbow, and the remaining two shoulder angles. It was identified they are moved in unison for the masters, while the novices present different frequencies or even lack of variation in some of the joints. After analyzing a longer set of data, hierarchical clustering shed some more light in the coordination of the different body parts.

A clear difference between novices and masters has been found. The research has shown that masters share traits with each other in all the ways to interpret data, while the intermediate and novice subjects do not have consistency throughout all the analyses. The action of experienced whisking involves the motion of the *chasen* in a line in the three dimensional space, in which most of the other parts do not contribute. This is achieved with the coordination of the arms. It has been demonstrated that there exists a common behavior for practitioners to strive for and converge into.