A NOVEL DEVICE FOR MEASURING FORCES AND MOMENTS DURING DYNAMIC JAR AND BOTTLE OPENING

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INTRODUCTION

Jar and bottle opening are a challenge for many people [1]. The maximal static twisting torques people can apply to different jars have been measured, indicating deterioration into older age [2]. This information does not, however, relate to the dynamic opening of jars/bottles as there was no anticipation by the subject of the release of the lid. Previsously described load measuring devices [3,4] have not recreated the dynamic nature of the package opening activity. To gain insight into the dynamic nature of jar/bottle opening, a device was designed to serve two key functions. The first was to measure the forces and moments applied to each half of the lid, i.e. by opposing hand segments. The second was to mimic an everyday jar and bottle, both dimensionally and in the way the lid would rotate open once the required torque was generated by the subject.

METHODS

The device was designed such that it could have two distinctly different configurations; a jar (Figure 1) and a bottle, using one central 'core' and adding or removing components as necessary. The core used two fixed Nano 25 six degree-of-freedom force/torque transducers (ATI Industrial Automation, Apex, NC) with one measuring the force exerted by the subject's thumb/palm, and the other the opposing combination of finger forces.

The device incorporated, as appropriate either an inverted jar or bottle lid (Figure 1). The torque profile was therefore representative of that which occurs during opening of intact packaging, making the task truly dynamic in nature.

8 young (mean age 26.2) and 11 older adult (mean age 76.4) subjects were asked to perform 3 jar and 3 bottle opening tests. The forces were recorded simultaneously with the motion of the jar/bottle lid relative to the jar/bottle body using reflective markers and an 8-camera Vicon motion analysis system (0xford Metrics, UK). Power grip readings were also taken for each subject using a Jamar® Hand Dynamometer (Lafayette Instruments, Lafayette, IN).

RESULTS AND DISCUSSION

Results (Table 1) show that young adults tend to open jar lids more quickly than older adults. There were no clear differences in the lateral 'squeeze' or compressive forces exerted on the lids. Older adults tended to exert a higher percentage of their maximal power grip when applying the lateral force.

These results suggest that while older adults have to exert more effort to open a jar, they do so in a slower, more controlled manner than young adults. The end result is the same (i.e. the jar is opened) but there seems to be a difference in approach and technique.

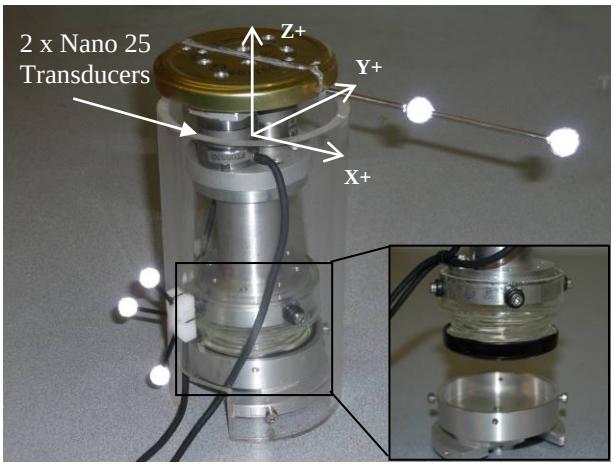

Figure 1: Custom jar device, showing two isolated lid sections, inverted real jar lid (section view) and two Nano 25 F/T transducers. Jar axes system shown.

CONCLUSIONS

A device was designed and manufactured that allowed the quantification of jar and bottle opening kinetics for a representative dynamic opening action. There were differences in opening technique between young and old.

ACKNOWLEDGEMENTS

The authors would like to thank the Strategic Promotion of Ageing Research Capacity (SPARC), Barr's Sort Drinks Ltd, Crown Packaging UK and all volunteer subjects.

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Table 1: Comparison of results between groups for jar opening activity at opening point. Axes shown in Figure 1. Mean (S.D.)

Subject Group	Opening Speed (rads/s)	Lateral Force, Fy (N)	Compressive Force, Fz (N)	Lateral Force as % of Power Grip
Young Adults	1.6(0.8)	92.9(18.9)	-42.8(8.1)	26.7(7.9)
Older Adults	0.9(0.4)	94.7(22.9)	-48.6(16)	44.5(15.9)