Editorial

Searching for Meaningful Differences in Viscosity

The preceding article by Garcia, Chambers, Matta and Clark [1] exposes a serious flaw in our pervasive assumptions about texture modification as an intervention for dysphagia. Namely, Garcia et al. have successfully demonstrated that following a recipe and combining a prescribed amount of thickening agent with a prescribed volume of liquid does not necessarily result in a texture-modified product with predictable flow properties. The data presented by Garcia et al. [1] clearly illustrate that the final product depends on the nature of the selected thickening agent, the nature of the original thin liquid, and time. These factors are shown to significantly influence the viscosity of the final product, even in a controlled laboratory setting. The clarity of Garcia et al.’s [1] findings compels us to take notice, and consider the implications of this research for daily clinical practice.

In fact, Garcia and colleagues [1] are not the first to report this phenomenon in the dysphagia literature. In 1997, Pelletier [2] used five different commercially available thickening powders to mix 4-oz samples of three different liquids (apple-juice, 2% milk and black coffee) to resemble maple-syrup, honey and pudding, using the manufacturer’s directions. Perceptual ratings of taste and consistency were made by a panel of raters using a 3-point scale ranging from poor to good at 1 minute, 5 minutes and 17 hours post mixing. Pelletier’s results [2] showed that the judges perceived differences in the viscosity of each liquid-thickener combination at all time points, and that no single thickening agent reliably achieved a judgement of “good” in its ability to match the consistency of maple syrup, honey or vanilla pudding when mixed with apple juice.
Garcia et al. [1] have improved upon the methodology used by Pelletier [2], (particularly in their use of temperature control and instrumentation to measure viscosity), yet their ultimate findings are surprisingly similar. Three of the five thickening agents (Thick & Easy®, Thick It®, and Thicken Up®) and three of the five liquids (apple juice, 2% milk and coffee) used in Garcia et al’s study [1] were identical to those studied by Pelletier [2]. In contrast to Pelletier [2], Garcia and colleagues [1] compared the resulting viscosity of their products to viscosity ranges proposed by the National Dysphagia Diet [3] for nectar-thick and honey-thick consistencies, (i.e., 51-350 and 351-1750 centipoise (cP) respectively, at a shear-rate of 50 reciprocal seconds). Their measurements were made at the recipe-prescribed “standard” time-to-thicken, and at 10- and 30-minutes post mixing. The findings reveal a confusing and alarming variety of viscosity measurements. At the label-prescribed time-to-thicken, four of the 25 nectar-like products were found to have viscosities in the thin liquid range (less than 50 cP); by 10-minutes post mixing, two of the 25 nectar-like liquids had viscosities in the honey-liquid range (more than 351 cP); and by 30-minutes, two additional nectar-thick samples had reached a honey-like viscosity. For the honey-thick liquids, the three measurement intervals respectively identified only 8, 9 and 10 of the 25 samples to be within the targeted National Dysphagia Diet range of 351-1750 cP. At the first measurement interval (standard time-to-thicken), all the other honey-thick samples showed thinner than desirable viscosities in the nectar-thick range. By 10-minutes post-thickening, 1 sample had thickened to a spoon-thick viscosity (i.e. more than 1750 cP), and by 30-minutes, this was true of 3 additional samples.

“Thickening liquids has been and continues to be one of the most frequently used compensatory interventions in hospitals and long-term care facilities” [4]. Yet, our literature contains very few studies to support this wide-spread intervention. It might surprise some readers
to learn that the available literature contains no evidence to suggest that texture modification reliably reduces aspiration or facilitates improved bolus clearance. Rather, the literature suggests that the influence of increased viscosity can be distilled primarily to temporal effects (increased durations of oral and pharyngeal transit [5, 6], time to peak lingual pressure[7], tongue-base to posterior-wall contact [5, 6] and UES-opening [5, 6]) with scattered additional findings of increased amplitudes in lingual force [8], lingual pressure generation [7, 9], and the range of upward hyoid movement [10, 11]. Yet, by far the majority (if not all) of these studies do not adequately define the viscosities of the texture-modified stimuli studied [12], and in many, the observed effects of viscosity are likely to be confounded by the density and flavour influences of barium [13-15].

To date, our literature has not determined the magnitude of the minimally meaningful difference in viscosity, namely how large a difference in viscosity is required to elicit altered swallowing physiology? Previous literature suggests that (at least at a perceptual level) the answer to this question may itself be a sliding scale. At the thinner end of the viscosity continuum, we are able to detect small changes in viscosity [16], and these might be sufficient to influence lingual bolus control or swallow timing. At the other end of the spectrum, however, we are much less sensitive to increases in the viscosity of thicker substances, and may need differences of much greater magnitude to elicit differences in swallowing behaviours [16]. However, several papers suggest that healthy individuals do not, in fact, show viscosity-dependent modulations in tongue movements, lingual pressures or hyoid movement across stimuli within the thin to honey-thick viscosity range [17, 18]. Whether dysphagic individuals are more likely to exhibit differences in swallowing in responses to viscosity differences of smaller magnitudes remains an as-yet unanswered empirical question.
Both Pelletier [2] and Garcia et al. [1] have demonstrated time-dependency and product-dependent variability in the viscosity of thickened liquids under controlled circumstances, using carefully prescribed recipes. What should we make of these results? Does this inherent variability suggest that the widely presumed benefits of texture modification are a figment of our collective imagination? Certainly for patients who appear to lose control of thin liquids, providing a more viscous bolus makes good, logical sense. Conversely, for patients who exhibit difficulty with oropharyngeal transport of thicker substances like mashed potato, thinning the bolus is a logical and pragmatic intervention. However, from Garcia et al.’s data [1], it is clear that using set amounts of thickening agent with different liquids will not reliably yield end-products of equivalent viscosity. In Garcia et al.’s study [1], the magnitude of the observed viscosity variations across liquids ranges from 40-353 cP for nectar-thick liquids and from 114 to 3395 cP for the honey-thick liquids. It is notable that the magnitude of this variation exceeds the proposed size of entire centipoise-defined classification ranges within the National Dysphagia Diet [3] (i.e. 300 cP for the nectar-thick class and 1400 cP for the honey-thick class). We should also take serious note of Garcia et al.’s [1] evidence of time-dependent increases in the viscosity of liquids thickened with commercially available thickening agents. By 30-minutes post mixing, all liquids mixed with starch-based thickeners displayed increases in viscosity compared to the standard time-to-thicken measurement, with these increases ranging from 14 to 296 cP within the nectar-thick group and from 85 to more than 4000 cP within the honey-thick group. By contrast, liquids mixed with the gum-based thickening agents showed relatively stable viscosities across time, with slight thinning evident by 30 minutes (- 26 to + 4 cP for the nectar-thick samples and -18 to + 3 cP for the honey-thick samples). Without data from viscosity measurements at further intervals, we cannot speculate regarding the time necessary for the starch-thickened liquids to
achieve stability, nor whether further thinning would be likely within the gum-thickened liquids with additional time.

Garcia et al.’s findings [1] do suggest that it is unreasonable to expect manufacturers to define recipes that will produce similar products across all liquids. In defense of the manufacturers, it may also be unfair of us to evaluate their recipes using the National Dysphagia Diet guidelines for liquid viscosities, since the published recipes on product labels may well pre-date those guidelines, and the guidelines themselves are acknowledged to be a consensus-based proposal rather than an evidence-based criterion [3]. Beyond the clinical gut level of eye-balling thickness, and estimating when a liquid is “just right”, “too thin”, or “too thick” for any individual patient, it seems we have relatively little empirical evidence to guide us. Although the magnitude of the observed viscosity variations in Garcia’s data [1] is impressive, and certainly sufficient to make us question the validity both of thickening recipes and of the classification boundaries proposed within the National Dysphagia Diet [3], whether this variation is of sufficient magnitude to warrant real concern for our patients remains unclear. It appears that the question we need to address in future research, is that of defining the minimally interesting or minimally meaningful difference in viscosity for oropharyngeal swallowing physiology.

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