Lifting a cup of water with an immersion blender

With regard to the "The Puzzling Immersion Hand Blender Effect," I tried it in my kitchen and find that the effect is very sensitive to the diameter of the container of water. A glass whose diameter is similar to that of the blade guard (as in the photo in Ref. 1) can be readily lifted. However, when a plastic container with about double the diameter was tried, my blender could not lift it, even though the total weight of the new container and water was less than before. (I took care to ensure the spinning blades were fully immersed in both cases.) A significant downward force is felt when the blender is switched on. It is the reaction to that downward force that lifts the glass of water. I suggest that the coupling between the blender and glass is as follows. The water is centrifugally flung away from the curved blades in an outward and upward spiral, so that it corkscrews up the side of the glass. Since the water is pushed upward, the blender is pulled downward (which I counter with my muscles if the blender is not in contact with, say, the bottom of a sink full of water). That explains the force coupling between the blender and the water. Now the upward-traveling water strikes the inner surface of the glass. Because of the surface drag (often called "skin friction"), the water’s upward motion is largely arrested. This inelastic collision transfers upward momentum to the glass, thereby lifting it against gravity. However, if the diameter of the container is too large, the water flowing upward crests before it reaches the walls and there is no longer any vertical momentum transfer. (A more powerful blender could deliver greater velocity to the water, thereby explaining the lifting of the saucepan mentioned at the end of Ref. 1.) To test this explanation, I cut the bottom off a plastic cup of narrower diameter than my glass to make a sleeve that I inserted into the water. When the blender was turned on, the sleeve was pushed upward relative to the cup, supporting my hypothesis.


Carl E. Mungan

Physics Department, U.S. Naval Academy
Annapolis, MD 21402; mungan@usna.edu
The puzzling immersion hand blender effect

Chris Chiaverina, 4111 Connecticut Trail, Crystal Lake, IL

Science educator and magician Bob Friedhoffer recently shared a demonstration that he performs with an immersion hand blender and a glass of water. The demo is very simple, yet the physics behind it is not so obvious. He first submerges the blender’s blade in a glass of water. With the blade near the bottom of the glass, he turns on the blender and, voilà, lifts the glass and its contents off the table!

Bob reported that he has tried producing the effect with glasses and cups having different shapes and sizes. In some cases lift was achieved; in others it was not. Perhaps not surprisingly, he has also found that some blenders work better than others. He said that a particularly powerful blender once allowed him to pick up a small aluminum sauce pan.

It has been suggested that the Bernoulli effect is responsible for the lift. However, the jury is still out. We would like to hear from readers what they think is behind the effect. Send your ideas to fizzforfun@aol.com.