Bringing an Emerging Consumer Issue to the Classroom: The Bisphenol-A (BPA) Controversy

Russell N. James III, University of Georgia
Diann C. Moorman, University of Georgia

As consumer educators, we often seek to spur student interest and, ultimately, ignite a passion for consumer education and advocacy. Issues of current consumer policy frequently provide an excellent platform to achieve these goals. The most compelling issues are usually those with the potential to affect students' lives directly. When students get involved in an issue they find to be exciting, alarming, or important, old classroom facts can generate new levels of interest. The purpose of this paper is to outline how the current controversy over Bisphenol-A (BPA) can serve as an interesting and compelling example to demonstrate the real world dynamics of consumer advocacy, industry reaction, scientific debate, and policy consequences.

Scientific Origins

Bisphenol-A (BPA) is an artificial estrogen. When bonded together in a chain of molecules it forms part of an extraordinarily useful plastic called polycarbonate. BPA containing plastics are used as packaging for thousands of consumer products such as microwave dinners, water bottles, hard plastic baby bottles, interior coating for canned food, and in-housing construction products like water pipes and water storage tanks.

Early scientific notice of BPA leaching from plastic containers was reported in a 1993 article in the journal of *Endocrinology* (Krishnan, Stathis, Permuth, Tokes, & Feldman, 1993). These Stanford University scientists were not studying BPA or plastics at all. Rather, they were conducting an experiment to determine whether a particular organism (sacchoromyces cerevisiae) produced estrogens. However, the organism was grown in a culture using distilled water that had been autoclaved in plastic

(polycarbonate) containers. The researchers discovered that the estrogen components they were detecting were not from the organism, but from the distilled water. During the autoclaving process (where the bottle was heated under pressure), the artificial estrogen BPA was released from the plastic into the water.

Researchers at the Universidad de Granada in Spain confirmed that BPA leached from the lacquer coating of food cans into food eaten by consumers (Brotons, Olea-Serrano, Villalobos, Pedraza, & Olea, 1995). Researchers at the University of Missouri made an additional discovery (Nagel et al., 1997). Feeding BPA to pregnant mice at levels within the range of consumer exposure altered the male offspring's adult reproductive system. The first industry response came quickly as the Can Manufacturers Institute retracted a report issued the previous year (Society of Plastics Industry, 1996), claiming that their improved simulation methods indicated a lower amount of BPA entering food from can linings (Hoyle & Budway, 1997). University of Missouri researchers published a response questioning these findings, given that previous research using liquid present in canned vegetables found BPA levels well over three times the estimated levels provided by the Can Manufacturers Institute (Welshons, vom Saal, & Nagel, 1997).

Since that time, many additional studies have been conducted to establish the amount of BPA leaching into consumer foods from sources such as plastic microwavable containers (Nerin, Fernandez, Domeno, & Salafranca, 2003), plastic baby bottles (Brede, Fjeldal, Skjevrak, & Herikstad, 2003), plastic food wrap (Lopez-Cervantes & Paseiro-Losada, 2003) and canned food and coffee (Kang, Kito, & Kondo, 2003; Kang & Kondo, 2002), as well as into consumer water through plastic water bottles and plastic water storage tanks (Bae, Jeong, & Lee, 2002).

Approximately 176 scientific studies have been published on the low dose effects of BPA in animals (vom Saal, 2006). Of those, 149 have reported significant, and often adverse, effects. However, 27 studies have reported no evidence of harm. The funding source of this divergent group of studies is particularly interesting.

Whereas only 7% of the 163 studies sponsored by government funding found no evidence of harm, precisely 100% of the 13 published studies sponsored by chemical companies found no evidence of harm. Furthermore, the majority of government-sponsored studies, which found no evidence of harm, used rats from a particular colony (Charles River Sprague-Dawley colony), which are now believed to have been unusually resistant to these effects (vom Saal, 2006).

Public Health Connections

To date, scientific tests on the impact of BPA have been conducted only on laboratory animals. Nevertheless, the potential consequences of BPA are of particular interest from a public health perspective. The concern for human impact is quite real. Low doses of BPA, especially when ingested during pregnancy, have been linked to several health outcomes in humans, most prominently obesity (Howdeshell, Hotchkiss, Thayer, Vandenbergh, & vom Saal, 1999; Masuno et al., 2002; Ogden et al., 2006), early puberty in females (Herman-Giddens et al., 1997; "More girls experience early puberty," 2000; Howdeshell et al., 1999; Vandenberg et al., 2007), and lowered sperm count (Metcalfe et al., 2001; Swan, Elkin, & Fenster, 1997; Yonemoto & Tohyama, 2001). Additional research has confirmed significant levels of BPA in the amniotic fluid of pregnant women (Ikezuki, Tsutsumi, Takai, Kamei, & Taketani, 2002).

Classroom discussions about emerging health trends and their causes, such as those related to BPA, can highlight the role of consumer information and its impact on societal well-being.

Barriers to Consumer Advocacy

The regulation of BPA faces a number of barriers which consumer advocacy can help overcome. To begin with, polycarbonate is not tested as a consumable drug. It is simply packaging. As Dr. Frederick vom Saal, one of the authors of the

original 1997 study, notes, "If BPA was treated as a drug, it would have been pulled immediately" (Faddis, 2005, p. 6). However, he remains convinced that "This evidence will ultimately convince federal regulatory agencies that BPA should be illegal for use in food and beverage containers" (McGowan, 2003, p. 5).

Another barrier to regulatory enforcement has to do with the odd science of BPA and other hormones. Typically, regulators measure the harmfulness of a substance by testing very high doses in animals. The high dosage is gradually reduced until a safe dosage amount is found, and that level is then used as the basis for calculating acceptable consumer exposure. However, BPA appears to exhibit an inverted U-shaped dose-response curve. In other words, low doses of BPA produce results unpredicted by, and often opposite to, high doses (Takai et al., 2000). It may be that at very high doses organisms recognize the hormone as a foreign substance, but at low doses it is treated as an internally-produced hormone (Timms et al., 2005). The typical consumer safety testing procedures do not appear to be well suited to address the unusual nature of BPA.

Of course, one of the largest barriers to effective consumer advocacy is the financial capacity of an enormous industry. A 2005 press release reported that fifteen corporations manufacture over 6.4 billion pounds of BPA each year (Faddis, 2005). Although Dr. vom Saal contends that the BPA chemical could be replaced in plastics right away with no noticeable difference to the public (Faddis, 2005), such a transformation would negatively impact the multi-billion dollar BPA manufacturing industry (McGowan, 2003). Because of this economic impact, the plastics industry has been aggressively defending the use of BPA.

Policy Discussions

With growing scientific information questioning the safety of BPA, discussions about potential legislative responses also are increasing. In 2005, the California legislature considered a bill (AB 319) to ban the use of BPA in containers intended for use by

infants (Kay, 2005). Although this bill did not pass, on June 6, 2006, the San Francisco Board of Supervisors unanimously approved legislation banning the manufacture, sale, and distribution of infant care articles, such as baby bottles, containing BPA (Kay, 2006). BPA related legislation also has been proposed in Maryland and Minnesota.

The growing potential for legislative responses to BPA concerns has generated competing sources of information about the nature of the risk. The plastics industry maintains its consumer information at http://www.bisphenol-a.org. Competing sites include http://www.ourstolenfuture.org and http://www.mindfully.org. An excellent example of the kind of scientific dispute generated by these legislative proposals can be found at http://www.ourstolenfuture.org/Policy/2006/2006-0107ab319.html.

This ongoing legislative and scientific clash provides students with the opportunity to read from competing information sources and to form their own conclusions. A written or verbal presentation of those conclusions, can serve as an excellent methodology to generate personal involvement and independent thought. Students also can gain exposure to international consumer protection processes by researching how different countries are addressing this issue. For example, in Great Britain, there is ongoing debate over BPA usage within policymaking agencies (World Wildlife Federation, 2003); and in Japan, concerns over BPA have resulted in a dramatic drop in plastic tableware usage ("Chemical in plastic tableware," 1998).

Although research on the BPA controversy tends to be scientific in nature, it can still be presented within a consumer education context. Abstracts summarizing the findings from scientific journal articles are usually available via a search on Google Scholar (http://scholar.google.com). With some patience, and the use of a scientific dictionary, these abstracts can be made accessible to the layperson. Successful translation of many abstracts is possible, even without the expertise necessary to

analyze the details of the full journal article. See Table 1 for additional teaching resources.

Table 1
BPA Teaching Resources for Consumer Educators

News articles on BPA:
http://www.time.com/time/teach/psych/unit2_article6.html http://www.bioedonline.org/news/news.cfm?art=1788 http://www.bioedonline.org/news/news.cfm?art=1747 http://newsinfo.iu.edu/news/page/normal/3957.html (5th article)
PowerPoint presentations related to BPA:
http://blumberg.bio.uci.edu/2b-sp2006/Brittani-BPA.ppt http://www.crra.com/2005conf/presentations/monday/monday_meyers.ppt http://www.wecf.de/cms/download/REACH/DR_ChemicalsWomen_Dec04.ppt http://www.mawaterquality.org/themes/policy/ed_workshop_docs/5_Myers_ED_and_Human_Health.pdf
Short video of high school student investigating BPA:
http://www.nkcsd.k12.mo.us/community/foundation/nicole%20003.wmv
Articles on Dr. Frederick vom Saal at the University of Missouri:
http://atmizzou.missouri.edu/may05/vomsaal.htm http://atmizzou.missouri.edu/jun03/plastics.htm http://www.ourstolenfuture.org/Myths/vomsaal.htm http://www.ssu.missouri.edu/courses/AgEc156/toxic_avenger.htm

Conclusions

While a classroom discussion may not resolve the BPA debate to everyone's satisfaction, this topic can provide excellent opportunities to engage students in the real world of consumer issues. There is perhaps no better way to gain an understanding of how industry, science, politics, advocacy and policymaking all work together in the field of consumer education than to engage in a lively and controversial discussion about issues that may be affecting everyone. For some students, the BPA discussion may provide just the right catalyst to ignite a passion for consumer issues.

References

Bae, B., Jeong, J. H., & Lee, S. J. (2002). The quantification and characterization of endocrine disruptor bisphenol-A leaching from epoxy resin. *Water Science and Technology, 46*(11), 381-387.

Brede, C., Fjeldal, P., Skjevrak, I., & Herikstad, H. (2003). Increased migration levels of bisphenol A from polycarbonate baby bottles after dishwashing, boiling and brushing. *Food Additives and Contaminants, 20*(7), 684-689.

Brotons, J. A., Olea-Serrano, M. F., Villalobos, M., Pedraza, V., & Olea, N. (1995). Xenoestrogens released from lacquer coating in food cans. *Environmental Health Perspectives, 103*(6), 608-612.

Chemical in plastic tableware causes health scare. (1998, June). *Asia Pacific Biotech News, 2*(5), 100.

Faddis, J. (2005, April 13). Scientific research mounts against widely used chemical in everyday plastic products. *Research at MU: News & Press Releases*. Retrieved August 30, 2007, from https://www.research.missouri.edu/news/stories/050413_plastic.htm

Herman-Giddens, M. E., Slora, E. J., Wasserman, R. C., Bourdony, C. J., Bhapkar, M. V., Koch, G. G., & Hasemeier, C. M. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: A study from the pediatric research in office settings network. *Pediatrics, 99*(4), 505-512.

Howdeshell, K. L., Hotchkiss, A. K., Thayer, K. A., Vandenbergh, J. G., & vom Saal, F. S. (1999). Exposure to bisphenol A advances puberty. *Nature, 401*, 763-764.

Hoyle, W. C., & Budway, R. (1997). Bisphenol A in food cans: An update. *Environmental Health Perspectives, 105*(6), 570-571.

Ikezuki, Y., Tsutsumi, O., Takai, Y., Kamei, Y., & Taketani, Y. (2002). Determination of bisphenol A concentrations in human biological fluids reveals significant early prenatal exposure. *Human Reproduction, 17*(11), 2839-2841.

Kang, J. H., Kito, K., & Kondo, F. (2003). Factors influencing the migration of bisphenol A from cans. *Journal of Food Protection, 66*(8), 1444-1447.

Kang, J. H., & Kondo, F. (2002). Bisphenol A migration from cans containing coffee and caffeine. *Food Additives and Contaminants, 19*(9), 886-890.

Kay, J. (2005, March 31). Legislature considers bill to ban chemical from kids' products: Bisphenol A found in pacifiers, toys and baby bottles. *The San Francisco Chronicle*, p. B-1.

Kay, J. (2006, November 19). San Francisco prepares to ban certain chemicals in products for tots, but enforcement will be tough - and toymakers question necessity. *The San Francisco Chronicle*, p. A-1.

Krishnan, A. V., Stathis, P., Permuth, S. F., Tokes, L., & Feldman, D. (1993). Bisphenol-A: an estrogenic substance is released from polycarbonate flasks during autoclaving. *Endocrinology, 132*(6), 2279-2286.

Lopez-Cervantes, J., & Paseiro-Losada, P. (2003). Determination of bisphenol A in, and its migration from, PVC stretch film used for food packaging. *Food Additives and Contaminants, 20*(6), 596-606.

Masuno, H., Kidani, T., Sekiya, K., Sakayama, K., Shiosaka, T., Yamamoto, H., & Honda, K. (2002). Bisphenol A in combination with insulin can accelerate the conversion of 3T3-L1 fibroblasts to adipocytes. *Journal of Lipid Research, 43*(5), 676-684.

McGowan, M. (2003, June). Uncovering a hidden danger. *Mizzou News.* Retrieved August 30, 2007, from http://atmizzou.missouri.edu/jun03/plastics.htm

Metcalfe, C. D., Metcalfe, T. L., Kiparissis, Y., Koenig, B. G., Khan, C., Hughes, R. J., Croley, T. R., March, R. E., & Potter, T. (2001). Estrogenic potency of chemicals detected in sewage treatment plant effluents as determined by *in vivo* assays with Japanese medaka (*oryzias latipes*). *Environmental Toxicology & Chemistry, 20*(2), 297-308.

More girls experience early puberty. (2000, March 31). *CNN.com*, Retrieved August 30, 2007, from http://archives.cnn.com/2000/HEALTH/children/03/31/early.puberty.wmd/index.html#0

Nagel, S. C., vom Saal, F. S., Thayer, K. A., Dhar, M. G., Boechler, M., & Welshons, W. V. (1997). Relative binding affinity-serum modified access (RBA-SMA) assay predicts the relative in vivo bioactivity of the xenoestrogens bisphenol A and octylphenol. *Environmental Health Perspectives, 105*(1), 70-76.

Nerin, C., Fernandez, C., Domeno, C., & Salafranca, J. (2003). Determination of potential migrants in polycarbonate containers used for microwave ovens by high-performance liquid chromatography with ultraviolet and fluorescence detection. *Journal of Agriculture and Food Chemistry, 51*(9), 5647-5653.

Ogden, C., Carroll, M., Curtin, L., McDowell, M., Tabak, C., & Flegal, K. (2006). Prevalence of overweight and obesity in the United States, 1999 - 2004. *Journal of the American Medical Association, 295*(13), 1549-1555.

Society of the Plastics Industry. (1996). *Potential exposure to bisphenol A from epoxy can coatings.* Washington, DC: Author.

Swan, S. H., Elkin, E. P., & Fenster, L. (1997). Have sperm densities declined? A reanalysis of global trend data. *Environmental Health Perspectives, 105*(11), 1228-1232.

Takai, Y., Tsutsumi, O., Ikezuki, Y., Hiroi, H., Osuga, Y., Momoeda, M., Yano, T., & Taketani, Y. (2000). Estrogen receptor-mediated effects of a xenoestrogen, bisphenol A, on preimplantation mouse embryos. *Biochemical and Biophysical Research Communications, 270*(3), 918-921.

Timms, B.G., Hodeshell, L., Barton, S., Bradley, S., Richter, C. A., & vom Saal, F. S. (2005). Estrogenic chemicals in plastic and oral contraceptives disrupt development of the fetal mouse prostate and urethra. *Proceedings of the National Academic of Sciences, 102*(19), 7014-7019.

Vandenberg, L. N., Maffini, M. V., Wadia, P. R., Sonnenschein, C., Rubin, B. S., & Soto, A. M. (2007). Exposure to environmentally relevant doses of the xenoestrogen bisphenol-A alters development of the fetal mouse mammary gland. *Endocrinology, 148*(1), 116-127.

vom Saal, F. S. (2006). *Bisphenol A.* University of Missouri, Endocrine Disruptors Group. Retrieved January 30, 2007, from http://endocrinedisruptors.missouri.edu/vomsaal/vomsaal.html

Welshons, W. V., vom Saal, F. S., & Nagel, S. C. (1997). Bisphenol A in food cans: An update (response). *Environmental Health Perspectives, 105*(6), 571-572.

World Wildlife Federation. (2001). WWF's response to the Food Standards Agency's survey of the migration of bisphenol A from can coatings into food. In *Migration of bisphenol A from can coatings into food - Consultation responses* (p. 1-8). Retrieved August 31, 2007, from http://www.food.gov.uk/multimedia/pdfs/bisacanresponse.pdf

Yonemoto, J., & Tohyama, C. (2001). Bisphenol A affects spermatogenesis in the adult rat even at low doses. *Journal of Occupational Health, 43*(4), 185-190.

Russell N. James III is Assistant Professor, Department of Housing & Consumer Economics, 203 Consumer Research Center - House C, University of Georgia, Athens, GA 30602; (706)206-3518; E-mail: rjames@uga.edu

Diann C. Moorman is Assistant Professor, Department of Housing & Consumer Economics, 209 Dawson Hall, University of Georgia, Athens, GA 30602; (706)542-5661; E-mail: dmoorman@fcs.uga.edu