

## *Linear Combinations of Population Averages*

1. Abuse of substances containing toluene (such as glue) can produce neurological symptoms. In an investigation of the mechanisms of the toxic effects of toluene, researchers measured concentrations of the chemical noradrenaline in the brains of rats, some of whom had been placed in chambers containing a toluene laden atmosphere (unit of measurement: nanograms [one billionth of a gram] per gram [ng/g] of brain tissue). Which rats were exposed to toluene was randomly determined.

Population	Population Average Brain Noradrenaline Content (in ng/g)
Rats placed in an atmosphere containing toluene	$\mu_1$
Rats not exposed to toluene	$\mu_2$

Research (i.e. alternate) hypothesis:

Is the expected noradrenaline content of the brains of rats who have been placed in an atmosphere containing toluene more than 15% greater than that of rats who have not been exposed to toluene?

On average, does a toluene laden atmosphere produce an increase of more than 15% in rat brain noradrenaline content (when compared to no exposure to toluene)?

$$L_1 = \mu_1 - 1.15 \mu_2$$

$$H_0 : L_1 = 0 \quad \text{versus} \quad H_A : L_1 > 0$$

2. (One) day old male chicks received a hormone injection. Some were given testosterone, while others received dehydroandrosterone. Chicks were randomly assigned to exactly one of the two hormones. Comb weight at day 15 was measured for each chick (unit of measurement: milligrams [mgs]).

Population of male chicks injected at day 1 with	Population Average Comb Weight At 15 Days (in mgs)
Dehydroandrosterone	$\mu_1$
Testosterone	$\mu_2$

Research (i.e. alternate) hypothesis:

Are combs of testosterone injected 15 day old male chicks more than 25 milligrams heavier than combs of dehydroandrosterone injected 15 day old male chicks, on average?

$$L_2 = \mu_2 - \mu_1$$

$$H_0 : L_2 = 25 \quad \text{versus} \quad H_A : L_2 > 25$$

3. Wood veneers made by five different manufacturers were subjected to an abrasion test. Veneer squares were subjected to the same stress for the same amount of time, after which wear was measured for each veneer square. The unit of measurement for wear is unspecified, but higher wear values denote more wear, and, hence, less resistance to abrasion.

Veneer Brand	Population Average Wear
ACME	$\mu_1$
AJAX	$\mu_2$
CHAMP	$\mu_3$
TUFFY	$\mu_4$
XTRA	$\mu_5$

Note that ACME and AJAX are made by U.S. Company A, CHAMP is made by U.S. Company B, while TUFFY and XTRA are products of non U.S. companies.

Research (i.e. alternate) hypothesis:

Is expected wear for wood veneers made by foreign companies more than 0.2 wear units greater than expected wear for wood veneers made by U.S. companies?

Do wood veneers made by foreign companies wear more than 0.20 units more than wood veneers made by U.S. companies, on average?

$$L_3 = (1/2)(\mu_4 + \mu_5) - (1/3)(\mu_1 + \mu_2 + \mu_3)$$

$$H_0 : L_3 = 0.20 \quad \text{versus} \quad H_A : L_3 > 0.20$$