

Can breeding bird density influence vocal individuality in bird song?

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Abstract:

Individuality is defined as the characteristics that determine the differences from one individual in species from another individual of the same species. Many animals use acoustic signals to communicate. These signals send messages about territorial defense, mate attraction and kin-ship. The ability to recognize who is singing is important for neighbor-stranger discrimination. Discrimination is also important if a species lives in a group or in colonies. It has been shown that there is a relationship between social group size and individuality both in rodents and many swallows. However many bird do not live in social groups but breeding bird density could also drive the evolution of individuality. We hypothesized that bird density will influence vocal individuality. We recorded 10 male birds from each of the following species; Green Tailed Towhees, House Wrens, Lazuli Buntings that sang 20 songs. Point counts in six open meadows and aspen patches were taken to measure density. These were then analyzed in Pratt acoustic software where various measurements of species were analyzed. The data was then analyzed with Beecher's information statistic to determine individuality. We found that larger-bodied - bird species were less dense. We found a positive relationship between breeding bird density and individuality but data were insufficient to reach significance. With a larger sample we may be able to suggest that bird density does influence vocal individuality in bird song.

Introduction:

Individuality is defined as the characteristics that determine differences from one individual in species from another individual in that same species. Individuality in species have been defined by physical characteristics or artificial markings (Pollard et al., 2010). Many species though use acoustic signals which can be identified more easily. These signals send messages such as alarm calls, territorial defense and mate attraction. The ability to discriminate between conspecific signals allows individuals of species to identify favorable mates and determine if a competitor is nearby (Blumenbach, Dabelsteen and Pedersen, 2007). Individualized signals are also used to discriminate neighbors and strangers songs (Yasukawa, Bick, Wagman and Marler, 1982). By being able to identify a neighbor allows an individual to know if his territory is at risk or not (McGregor, 1991). Identifying conspecific sounds has also been important in parent kin recognition calls. In large colonies such as the *Phoenicopiterus ruber* where there are thousands of individuals makes it difficult to stand out (Mathevon, 1997).

Social group size may drive the evolution of individualized calls. In sciurid rodents larger social groups showed that individuals have more individualized calls (Pollard and Blumstein, 2011). Carolina Chickadees *Poecile carolinensis* that lived in groups of two to six also had more

distinct songs (Freeberg and Harvey, 2008). In contrast non-colonial or non-very social species such as barn swallows, *Hirundo rustica*, and northern rough-winged swallows, *Stelgidopteryx serripennis*, exhibit a lower degree of individuality in their parent-offspring calls (Beecher, 1988). The hypothesis that sociability may be a force behind individuality has been shown in species living in groups or colonies. How avian species in non-social groups are individualized is unclear.

Many avian species do not live in social groups, but rather defend territories and create what are referred to as neighborhoods. Neighborhoods consist of multiple individuals of the same species living in a particular location (Stoddard et al., 1991). If more birds of the same species live in the same area, density of a certain bird species may play a role in individuality in that species song. We hypothesize that breeding bird density will impact individuality in bird song. In this study recorded multiple bird species to determine if density is a force of individuality in multiple bird species. In 2011 a preliminary study was performed on Lincoln's sparrows, *Melospiza lincolnii*, and mountain white-crowned sparrows, *Zonotrichia leucophrys oriantha* (McClain and Blumstein, 2010). Mountain white-crowned sparrows were more social species and showed more individualized compared to the Lincoln's sparrows. We record new species including: Green Tailed Towhees (*Pipilo chlorurus*), House Wrens (*Troglodytes aedon*), and Lazuli Buntings (*Passerina amoena*). Using Beecher's statistics we analyze individuality in bird song between in these species. Beecher's was used to analyze the individuality because it considers number of songs, number of recording sessions, sample size of individuals and the number of traits in a song. The information Beecher statistic calculates a number, the higher the number the more individualized the individual.

Methods:

Recordings:

Bird species were recorded between the hours of 0500am to 0930am during the breeding season. Birds were recorded along Gothic road and other adjacent trails. Birds were recorded from a distance of 5 to 20m depending on how close the bird allows the recorder. They were recorded with a Sennheiser MZW 816 microphone (Sennheiser Electronic, Wedemark, Germany), Dcode PS-T power module (Denecke Inc., North Hollywood, California, U.S.A.), onto a Marantz Professional Solid State Recorder PMD660 (D&M Professional, Itasca, Illinois, U.S.A.). Ten birds of each species were recorded in order to obtain recordings of twenty songs from each individual.

Song Analysis:

Songs were analyzed in spectrograms created in Praat sound analysis software (Phonetic Sciences, University of Amsterdam, Amsterdam, Netherlands). For each species different measurements were taken according to their song characteristics. The top 40dB of each song, normalized to 95% of peak amplitude, was analyzed.

Measurements for House Wren were: duration of total song, maximum frequency for total song, minimum frequency of song, bandwidth of song and number of syllables of song, number of phrases in song, number of trills, number of buzz notes, and number of harmonic

notes. Also song were broken into phrases, and within a phrase the measurements were; maximum frequency, minimum frequency, bandwidth, dominant frequency, number of syllables. Also separate measurements were made for the bubbly phrase including all the measurements for a regular phrase, along with high to low transitions and number of motifs (Fig.1).

Lazuli Bunting measurements were split into total song measurements and phrase measurements. Total song measurements taken: song duration, maximum frequency, minimum frequency, bandwidth, number of trills, number of syllables and number of phrases. In each phrase measurements were: phrase duration, maximum frequency, minimum frequency, bandwidth, dominant frequency and number of syllables (Fig 2).

Point Count Analysis:

Point counts were taken at twelve different locations, six open areas and six aspen patches . Point counts for each side were performed six times each. Before the each point count started we waited three minutes before we started. Then for another ten minutes any bird seen or heard was recorded by species and distance.

Density Estimates:

Point count data was analyzed in DISTANCE. Three models were used to determine the best estimate hazard rate, half-normal key and uniform key. The best fit model for each species was then used in our density data.

Data Analysis:

Data from the spectrogram analysis were then standardized by calculating residuals. These residuals were then squared. The sum of the squared residuals was calculated. This was then divided by the df value of 190. Then the square root of that number was taken. The square root was then used to divide the original raw data to standardize. The standardized data was then put into SPSS, where CRITERIA MINEIGEN(.01) and ITERATE(25), NOROTATE, METHOD = CORRELATION was used. Some traits in the data set were not able to be analyzed in the statistics program. The traits that were analyzed in the statistics program were then considered factors. This provided new df and F values for Beecher' statistic. Beecher information statistics was calculated with significant factors ($p < .05$) to determine individuality.

Results:

The Lazuli Bunting and the House Wren had the greatest of levels of individuality. Green Tailed Towhees and Lincoln Sparrows had the lowest degree of individuality (Table.1). Bird's species with larger body masses also showed to have lower Beecher information statistics (Fig.4). The data showed that species with higher densities had more individuality (Fig.5).

Beecher statistics were shown too effected by the number of significant factors measured (Fig.6). They however were not impact by the number of traits (Fig.7).

Discussion:

Our results indicate that density may influence vocal individuality. The body size data showed that as body size increased, Beecher's information statistics decreased. Species that have larger body sizes have been to show have smaller densities which are consistent with our data. The data collected thus far did not a present a significant relationship between individuality and density. The data did however account for much of the variance present. With a larger sample size this trend could then be significant. The number of traits measured need to be examined further to determine their effect of individuality. The number of significant factors showed to have an effect on the Beecher statistics. The more significant factors the less individuality. In the future that a way needs to be found to standardize the traits measured among species.

Densities may play an important role in individuality. The denser a crowd the harder it is to stand out. In flamingo species in large colonies parts of their calls encode for individuality (Mathevo, 1997). Also as social group size increases individuality also increased (Pollard and Blumstein, 2011). Bird species in colonial and non-colonial groups showed distinct differences in individuality (Beecher, 1988). More species still need be studied in order to support the idea that vocal individuality is influenced by density.

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Table 1: Factors examined in analysis: Number of individuals for each species measured. The Beecher (Hs) is the measurement of individuality. Density measurements were calculated from point count measurements. Body mass data was collected from Birds of North America average male weight. Number of traits is the number of traits in the

Green Tailed Towhee	10	5.10	0.14	29	44	44	20
House Wren	10	10.12	0.78	10.7	29	21	15
Lincoln sparrow	10	6.8	0.26	18.7	29	29	26
White crowned sparrow	10	8.76	0.46	28.7	20	18	17

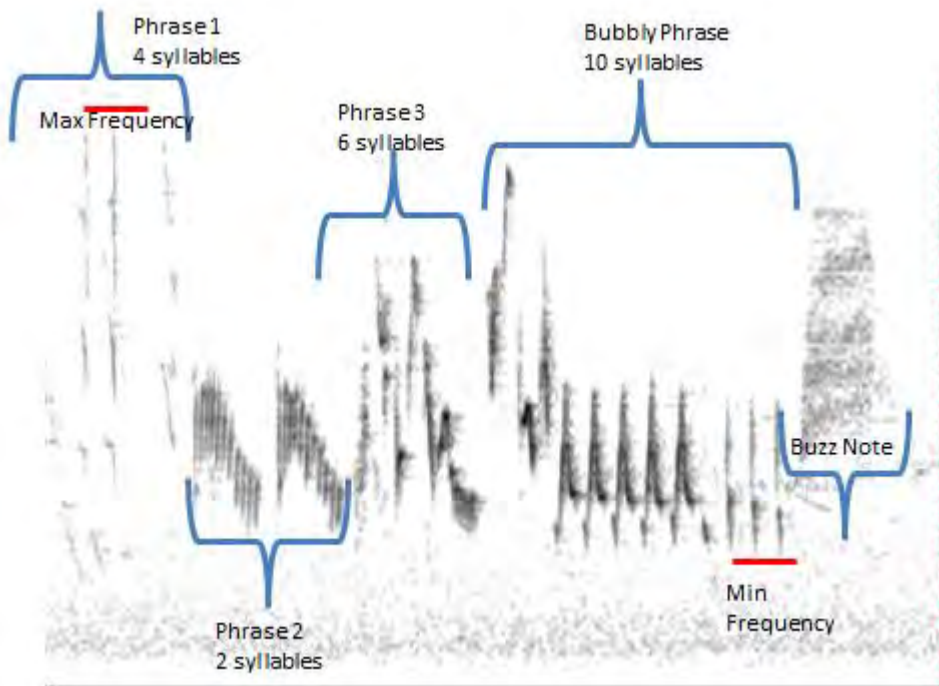
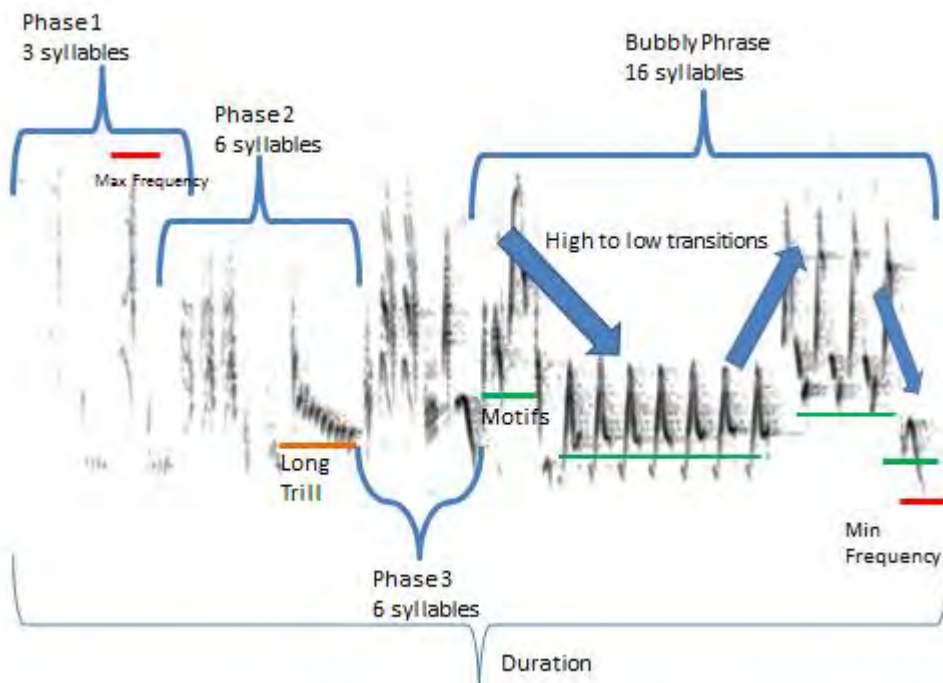


Figure 1: House Wren song and there measurements

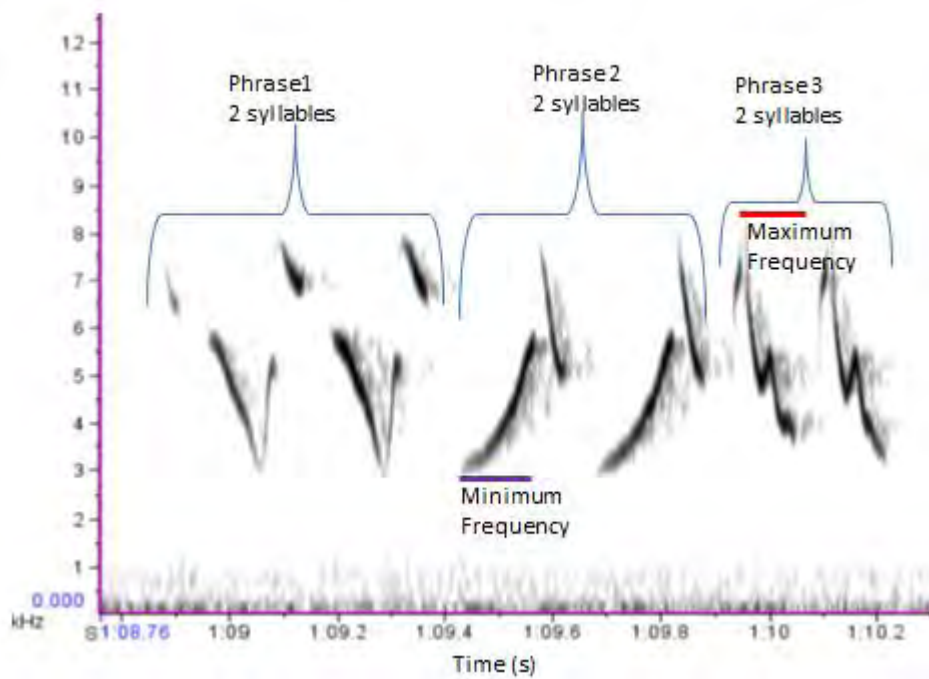
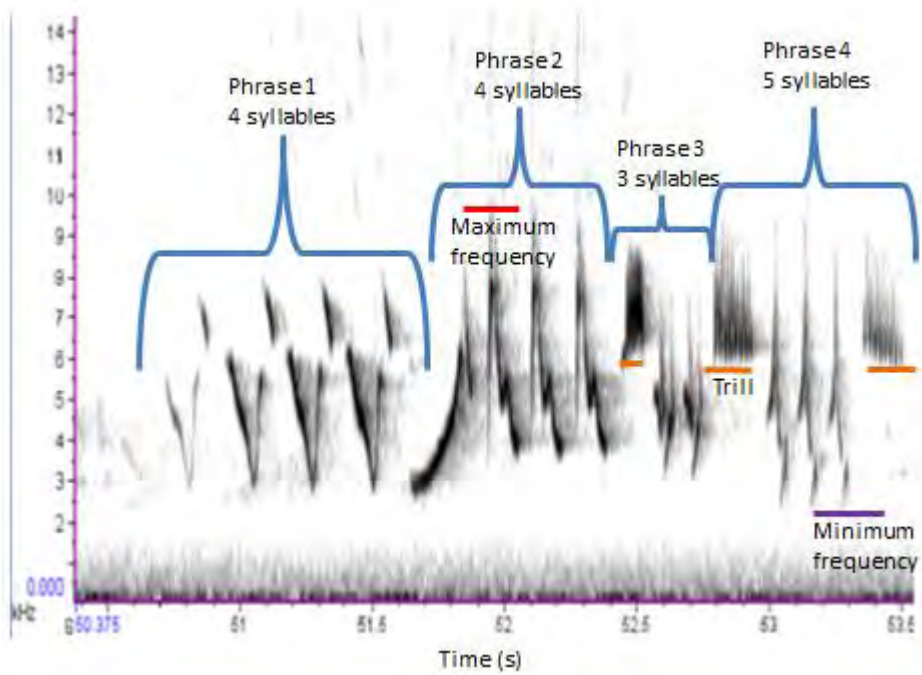


Figure 2: Measurements made on Lazuli Bunting songs

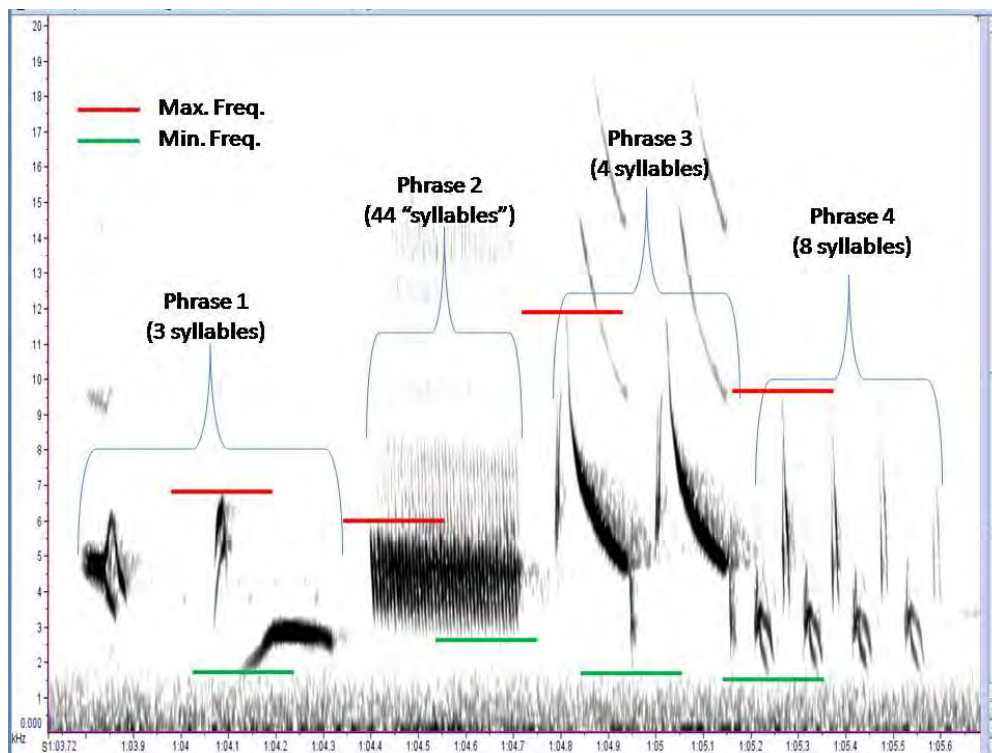


Figure 3: Measurements made on Towhee song

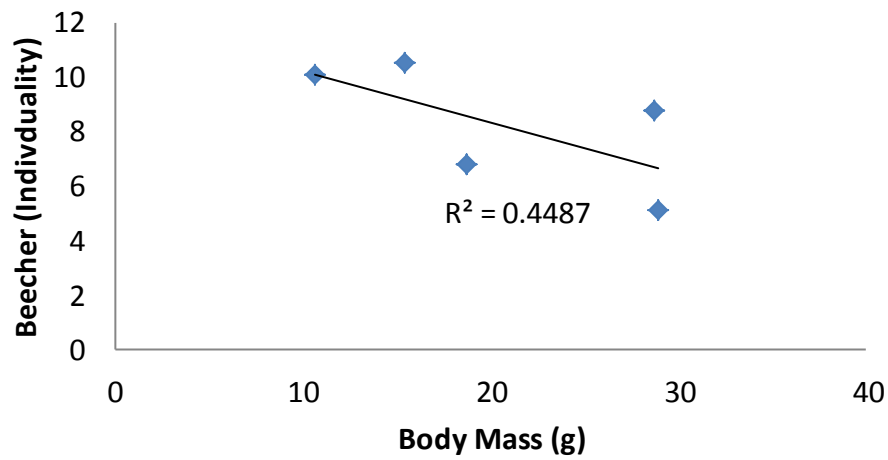


Figure 4: Body mass compared to individuality. N =5

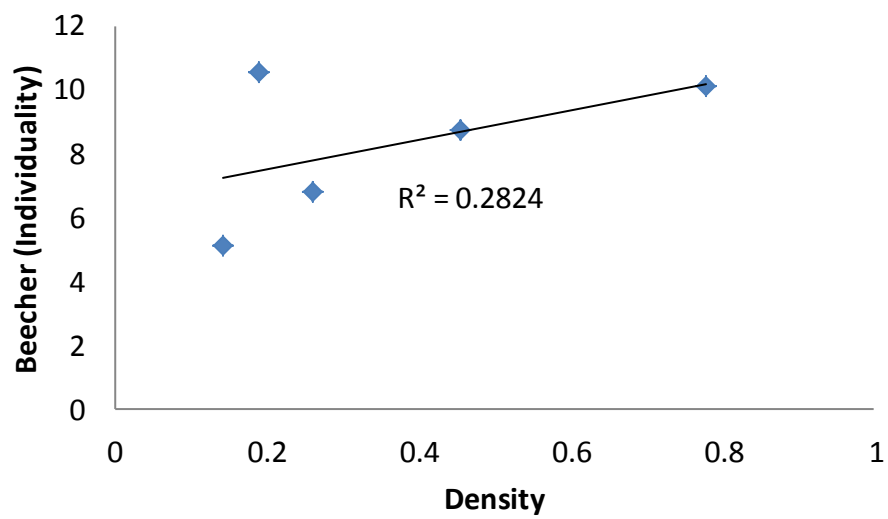


Figure 5: Density of bird species compared to individuality. N=5

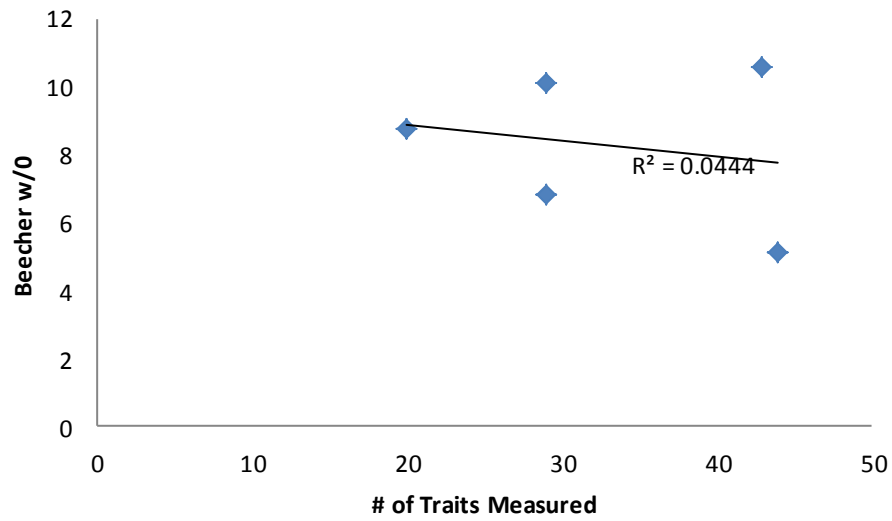


Figure 6 : Number of traits in species compared to individuality. N=5

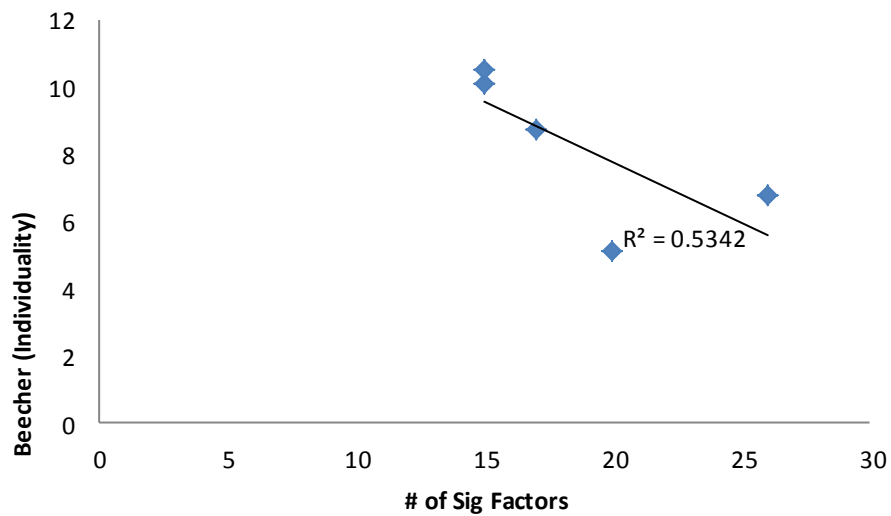


Figure 7 : Number of significant factors measured against individuality.