# Latent Transition Analysis: Video 1 - The purpose of LTA.

## Transcript

Video: <https://www.youtube.com/watch?v=UrpL9T-wwhc>

Oliver Perra: This is the first presentation of a series of three where I will go into more details about the goals and aims of latent transition analysis and how to conduct it. First, I will provide an example of a research problem to illustrate what latent transition analysis can do. I will then illustrate the purposes of latent transition analysis and I will emphasise how latent transition analysis is, basically, a person-centred approach to investigate change across time. Latent transition analysis allows to specify measurement models at each timepoint, which represent the different types of groups of participants in a study. And then it allows to investigate how individuals move from one group to another across time, that is structural changes across time.

So I'll start with this example. Let's assume we asked adolescents to report if they have frequently used any of these substances in the last month - alcohol, cannabis, and so on. Adolescents are 14 years of age the first time we ask them these questions, and just for the sake of the example, let's assume there are two genders - males and females. We observed different patterns of substance use in this sample and we may be interested in classifying these individuals into fewer groups that represent key differences in patterns of use that we observe, or as those groups may represent different propensities to substance use of the sample. And for this purpose, we might devise some arbitrary rules. For example, here I grouped in red the participants that reported use of two different substances and I grouped in orange those that reported use of one substance only. Whereas in black, I grouped those that did not use any of these substances. But these groups are made up based on arbitrary criteria I made up.

So imagine then we ask the same questions a year later to the same adolescents. At age 15, we may notice even more patterns of behaviours. And, for example, the patterns of behaviours I've circled here were not observed at age 14. And, once again, we may be interested in classifying individuals into fewer groups that can adequately represent the multiple patterns we observe in the sample. And I may use the same arbitrary rules I made up for the sample at age 14 or I may create additional rules. For example, the bright red individuals here are those that report the use of multiple substances. However, arbitrary rules are inadequate because they may not represent key differences across individuals and they are not reliable and meaningful across different studies.

Furthermore, when we are interested in classifying individuals into different groups based on their patterns of substance use, we are also often interested in investigating whether individuals change or not, and if they change, what are the patterns of change? For example, based on the gateway theory, I might be interested in checking and investigating whether individuals that use cannabis at 14 years of age move into categories of use that involve other substances, as well. And, again, if the categories were identified are based on arbitrary rules, we are often not able to provide reliable descriptions of change across time. So latent transition analysis is a statistical method that, based on probability rules, allows to answer these questions. In other words, latent transition analysis allows to identify fewer groups that represent variability of behaviour patterns at each age and investigates the patterns of change across time. What are the probabilities of individuals remaining in the same categories or moving into others across time and also allows to investigate what are the factors, for example gender, that can affect change over time?

So here I will describe in more details what are the purposes of latent transition analysis. Latent transition analysis extends the latent class model to repeated measures and longitudinal data. Latent class analysis is a person-centred approach. This means that when we observe a sample that shows different patterns of behaviour as in the example of adolescent substance use, we assume that what explains the interpersonal variability in the behaviours we observe is the fact that there are different categories of individuals who share the same propensity for displaying a pattern of behaviour, for example the same propensity to use some drugs. At each timepoint, we want to identify the groups or classes that can adequately explain the differences in behaviour we observe across participants.

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And in this example, I am assuming that at each age there are two underlying groups of adolescents - for example, users and abstainers, people that don't use substances. So this is the measurement model I specified for the data and example, and the basic measurement model is assuming that there are different typologies, different types of individuals at each age and those differences between individuals explain the different patterns of behaviour we observe. Once I have identified the categories of participants at each age, my question is how adolescents move from one category to another across time or if they move at all. For example, what is the probability that an abstainer at 14 years of age will become a substance user at 15 years, and what can affect this probability? For example, arm A is more likely to move from being abstainers at 14 to becoming substance user at 15 years of age. Latent transition analysis allows to answer all these questions using probability methods and, therefore, provides transparent and robust formal methods for answering questions about individual change over time.

So I have said that data transmission analysis, firstly, provides measurement models for data collected at repeated timepoints, and I will illustrate now the main characteristics of the measurement models. So the latent transition analysis extends latent class analysis to data collected over time or longitudinally. And I will summarise some of the key characteristics of latent classes here. If you want to know more about latent class analysis, I have prepared another resource for NCRM(?) that you can use. So, basically, starting from the example, we observed variability in 14-year-olds' responses to questions about substance use. Some adolescents report frequent use of alcohol and cannabis, others report frequent use of alcohol or cannabis, and most do not report any frequent use of these substances.

The first goal of latent transition analysis is to apply a latent class measurement model to each data collection point and, therefore, identify the number of underlying classes that can adequately explain the behaviour patterns we observe. We cannot observe these classes directly, but we can infer them using probability rules and use them to assign participants to classes based on their behaviour. Latent class analysis is a person-centred method because it is focussed on classifying persons and individuals. So let's assume that, in this example, three classes can optimally explain the patterns of behaviours we observed when adolescents are 14 years of age. These latent classes are supposed to be the underlying causal factors that explain the patterns of behaviours we observe. The patterns of substance use are explained by underlying typologies of individuals that differ in their propensities for substance use. For example, there may be a class of individuals I called 'users' that share propensity for frequent use of different substances, whereas individuals in the class I called 'experimenters' display propensity to use some substance of choice. And also I have called 'abstainers' tend to avoid frequent use of any substance.

Now, key assumptions of latent class analysis are that the classes we identify are exhaustive, which means that all the individuals in the sample belong to one of the latent classes. Each adolescent, for example, here will be either in the 'users' or the 'experimenters' or the 'abstainers' class. The classes are also mutually exclusive, so an individual will belong to only one class. For example, an abstainer cannot be an experimenter. So these classes are really typologies of individuals that share the same propensity to display a specific behaviour pattern. However, latent class analysis is a probabilistic model. So the association between the latent classes and the behaviours we observe, which we call indicators, is observed with error. So, for example, individuals in the abstainers class may have 96% probability of not using alcohol, but there is still a 4% probability that they may use it. Consequently, individuals' membership to the latent classes are also uncertain. We do not have the certainty that when we allocate an adolescent to the abstainer class, the adolescent actually belongs to that class, and that's because the behaviours we observe are observed with errors.

Latent class analysis allows to estimate that an individual may have, say, 89% probability of belonging to the abstainers class, but that means there is still 11% probability that the individual may belong to another class. And it is important to consider and control for this uncertainty when we regress date and class affiliation to predictors, as I will emphasise in other presentations.

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As we find a satisfactory measurement model for participants at one age, we should try to find another satisfactory one for the next timepoint - in this example, age 15. We might be tempted to assume that the same three classes we identified at age 14 could explain variability in adolescents' behaviour when aged 15. However, we might also find that the patterns of behaviour we observe at age 15 are more complex. To give an example, here there may be a pattern emerging where adolescents also frequently use ecstasy in combination with alcohol and cannabis. And the analysis may tell us that three classes are no longer sufficient to explain the patterns of behaviour observed and we need four classes at 15 years where a new class of 'abusers' emerge.

This example emphasises an important characteristic of data and transition analysis, that is latent transition analysis allows to identify underlying categories that emerge at different timepoints. In other words, it allows to identify new behavioural organisations that may emerge across time as well as qualitative changes across development. This is an important characteristic that distinguishes latent transition analysis from other approaches to longitudinal data, for example linear growth models that are more preoccupied with investigating changes in the level or degree of a behaviour. Latent transition analysis is more concerned with changes in the organisation of behaviour or it can be applied to questions about changes in the organisation of behaviour.

Together with the measurement model, latent transition also investigates the structural relationship between the latent classes that explain observed behavioural patterns. It does so by considering the multinomial logistic regressions between the latent classes at consecutive timepoints. For example, by regressing the latent classes at age 15 or those at age 14, we can investigate what are the associations between these patterns of behaviour. In particular, if we do consistently identify the same underlying classes at different timepoints, for example abstainers, we can investigate continuity and that is what is the probability that abstainers at age 14 will remain abstainers at age 15. At the same time, the analysis can tell us about discontinuity. What is the probability that abstainers at age 14 will transition to a different class characterised by other patterns of substance use? For example, what is the probability that an abstainer at 14 years will move to the abusers class at age 15?

Furthermore, latent transition analysis allows us to identify to investigate the role of covariates. For example, is gender associated with latent classes affiliation at age 14? Do females vary in the probability of being abstainers as compared to males? And do females and males vary in their membership at age 15, once we control for membership at age 14? And, as I will illustrate in the third presentation, latent transition analysis can also provide answers to more complex questions, for example, questions about whether the transition probabilities vary by gender, do females and males display different patterns of change across time.

To summarise, latent transition analysis is a person-centred approach applied to repeated measures and longitudinal data. There are two main goals of latent transition analysis. Latent transition analysis provides a person-centred measurement model that allows to identify subgroups of individuals that make up a sample at each measurement occasion with subgroups at different classes of individuals that share the same propensity to display a pattern of behaviour, and these propensities differ from those of individuals in other classes. Importantly, this person-centred approach allows to identify classes and behaviour organisations that emerge over time. As well as a measurement model, latent transition analysis also provides ways to investigate structural relationships between the underlying latent categories at different timepoints. It can thus investigate continuity and discontinuity across development, that is how individuals may transition from one category of behaviour to another one, and is therefore ideal for application to stadial theories of development.

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Latent transition analysis fulfils these goals using probability methods that are robust and transparent. In the next two presentations, I will delve more into these methods. So thank you very much.

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