Cannabis changes: Understanding dynamics of use and dependence

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CANNABIS DEPENDENCE
AND PEER SELECTION
IN SOCIAL NETWORKS OF FREQUENT USERS

Abstract
In a Dutch longitudinal study on the dynamics of cannabis dependence, at baseline 600 frequent cannabis users (≥ 3 days cannabis use per week in past 12 months) aged 18-30 years were interviewed. Nearly half of all participants (42%) met DSM-IV criteria for cannabis dependence in the 12 months prior to the interview. Participants were recruited by respondent-driven sampling; referrals were understood as proxy for social networks to explore peer associations and social exclusion. Analyses revealed that networks of frequent cannabis users were mostly heterogeneous. Cannabis dependence did not emerge as a main selector. However, within segments of networks some clustering of cannabis dependence (indicating differential inclusion), sex and ethnicity was found. Methodological questions are discussed regarding the applicability of respondent-driven sampling in noninjecting, nonmarginalized drug users. The study’s limitations are noted.

Key words: Cannabis dependence; Respondent-driven sampling; Social networks; Frequent cannabis use; Social exclusion.
Introduction

Drug use is often a social activity that occurs in an environment with other users (Fountain & Korf, 2007). In his classic study *How to become a marihuana user*, Becker (1963) argues that continued drug use is typically the result of social learning. In addition, Zinberg (1984) states that the effects of drugs experienced by users are influenced by three intertwined factors (drug, set, and setting), the latter including informal social control. The relevance of this social control lies in minimizing the harm of drug use, thus resulting in controlled intoxicant use. Violating the appropriate informal rules and norms regarding drug use within a group of users leads to social sanctions, and violators might eventually be excluded from the group. Alternatively, rituals and elements of social settings prevent uncontrolled drug use like dependence (Dunlap, Johnson, Sifaneck, & Benoit, 2005; Goode, 1999; Zinberg, 1984) and this explains why many cannabis users carefully choose when, where and with whom to use the drug (Reinarman & Cohen, 2007). Consequently, processes of social inclusion and exclusion may play an important role in drug using careers (cf. Vervaeke, van Deursen, & Korf, 2008).

In a wider context, Glueck & Glueck (1950) argue that, in line with the saying “birds of a feather flock together”, once deviant, juveniles are more likely to associate with deviant peers. In his classic theory of differential association, Sutherland (1947) stated that deviant behaviour is learned through association and interaction with other delinquents, especially in small, informal peer groups. Akers (1998), who further explored and refined Sutherland’s theory, found that the probability of frequent substance use increased when individuals in their social networks were more often exposed to favourable than to unfavourable definitions of use, including cannabis use. A crucial question in the current study is the extent to which frequent cannabis use and cannabis dependence is an important unifying factor in peer networks. Is cannabis the “feather” that makes users flock together? In line with Zinberg’s theory, it could be argued that cannabis dependence indicates less controlled use, and thus a violation of the social norms of drug use, which then leads to social exclusion from social networks of frequent but not dependent users. The question then is, whether cannabis dependent users become socially isolated (exclusion), or tend to congregate in social networks of dependent users (differential inclusion). Alternatively, it could be argued that frequent cannabis use by itself is already a violation of the social norms of controlled use, and therefore dependence will not lead to social exclusion from frequent but non-dependent users. The question then arises of which other factors might bond social networks of frequent cannabis users. The main purpose of the current study is to explore the role of social exclusion...
and inclusion, by analysing social networks within the total sample of 600 frequent cannabis users, who were recruited through respondent-driven sampling, by exploring the role of cannabis use—cannabis dependence in particular—and sociodemographic variables in peer associations in high-risk and dependent cannabis users. The relevance of these issues lies mainly in methodological strategies and insights for sampling in future research.

Internationally, high rates (11-13%) of cannabis dependence have been found in cohort studies among young adults (Boden, Fergusson, & Horwood, 2006; Noack, Höfler, Gründler, Schulz, & Paul, 2009) but longitudinal research on risk and protective factors for cannabis dependence—especially as regards the transition from regular use to dependence—is sparse. A major problem in previous studies targeting cannabis dependence is that general population surveys observe only small numbers of subjects with a diagnosis of cannabis dependence. For example, in the most recent German general population survey on substance use, only 113 of 7979 (1.1%) respondents aged 18-59 were lifetime cannabis dependent (positive on > 3 items of Severity of Dependence Scale (Kraus, Augustin, & Orth, 2005). Also, the number of cases in longitudinal studies is commonly too small to study transitions in cannabis dependence. Probably the best exception is a large ten-year follow-up study by Perkonigg et al. (e.g. 2008), but even in this study of 102 (3.1%) lifetime cannabis dependent participants, only 32 (1.4%) reported 12-month dependence. To avoid the problem of inadequate sample size, we initiated a 3-year longitudinal study with an enriched sample of (a) high-risk, heavy cannabis users and (b) dependent cannabis users. At baseline, respondent-driven sampling (RDS) was applied in recruiting 600 frequent cannabis users (> 3 days cannabis use per week in past 12 months) aged 18-30 years.

RDS is a specific snowball sampling technique. Snowball sampling is a nonprobability methodology based on the principle that respondents from the target population introduce researchers to other respondents or nominate new respondents who also belong to the target population. If participants play a more active role in recruiting new respondents (referrals), with recruiters often being financially compensated for successful referrals, then RDS is the more common term (Heckathorn, 1997; Salganik & Heckathorn, 2004). A key prerequisite for effective snowball sampling and for RDS is that respondents are part of social networks of people who belong to the target population. Snowball sampling is a true multipurpose technique. Snowball sampling is not only effective in obtaining data on populations of unknown parameters, it also allows inferences to be made about social networks and relations in which sensitive, illegal, or deviant issues are involved (Kaplan, Korf, & Sterk, 1987).
RDS and other types of snowball sampling make use of existing social networks. An interviewee assists in the recruitment of other respondents from the target population who belong to his or her social network. The first respondent in what is intended to become a chain of referrals is defined as a zero stage respondent or a seed. In this study we define seeds that do not generate referrals as loners (in the literature they are often referred to as “infertile seeds”), and being a loner is interpreted as an indicator of social exclusion (from/by other cannabis users). Few referrals and/or shorter referral chains are also used as indicators of social exclusion. Alternatively, successful seeds, and more referrals and/or longer chains, are seen as indicators of social inclusion or differential inclusion. In the analysis, we will first focus on cannabis dependence, and second on other cannabis use variables and sociodemographic characteristics. If dependence is a common feature in social networks of cannabis users, it can be expected that dependent users are more likely than non-dependent users to recruit other dependent users. Conversely, non-dependent users are more likely than dependent users to recruit other non-dependent users. In summary, the following questions will be explored:

1. Do loners differ from seeds with referrals and network members regarding cannabis dependence, cannabis use, and sociodemographic characteristics?
2. Do smaller chains differ from larger chains regarding cannabis dependence, cannabis use, and sociodemographic characteristics?
3. Do characteristics of seeds with referrals predict the prevalence of last-year cannabis dependence in referrals and social networks?
4. What are the defining factors in social networks of frequent cannabis users, in addition to or apart from cannabis dependence?

RDS and other types of snowball sampling not only provide information about each single respondent, but also about their social networks. A special advantage is that analyses are not limited to information of respondents about their peers (Heckathorn & Jeffri, 2001; Weerman, Bijleveld, & Averdijk, 2005). Respondents provide information about themselves, and network links are established behaviourally (Heckathorn & Jeffri, 2001). Thus, referral chains, when understood as (proxy for) social networks, can show how peer behaviours are associated, and thus inform about bonding factors.

Methods
General study design
Data were derived from CanDep, a longitudinal study on frequent cannabis users. The main objectives of the study are to investigate factors involved in
the transition from risky non-dependent cannabis use to cannabis dependence and vice versa, and to study the three-year natural course of DSM-IV cannabis dependence (see van der Pol et al., 2011, for a description of the methods of the study). Using baseline DSM-IV scores for last-year cannabis dependence we planned to recruit 275 risky but non-dependent cannabis users and 275 cannabis dependent users. From baseline, respondents will be followed for three years, with two follow-up face-to-face interviews and intermediate contacts by email, phone, or mail every 4-5 months between interviews. Transitions of cannabis dependence will be studied both quantitatively for the full sample and qualitatively in approximately 40 respondents. The study was approved by a Medical Ethics Committee (METIGG). All respondents provided written informed consent at the start of their participation in the study, acknowledging that their participation was voluntary. In this article we will focus only on the baseline data.

From September 2008 till April 2009, 600 frequent cannabis users in five Dutch cities were interviewed at baseline. Eligibility criteria included smoking cannabis at least 3 times a week during the past year and being 18-30 years of age. The minimum age was set at 18 years, because this is the age at which a person becomes legally an adult in the Netherlands and is also the minimum age that is allowed to visit coffee shops. The maximum age of 30 years was chosen because young adulthood is the period most strongly characterized by relatively high levels of cannabis use, discontinuation of cannabis use, and changing dynamics in life (e.g. relationships, study and employment). Data were collected with a computer-assisted personal interview, including most sections of the Composite International Diagnostic Interview (CIDI) version 3.0. The average duration of the interviews was 2.5 hours. After completion, respondents received financial compensation of 25 euro.

In the Netherlands, so-called coffee shops, where selling hashish and marijuana to consumers is tolerated under specific conditions (e.g. minimum age 18 years), make it relatively easy to access and recognize frequent cannabis users. The vast majority of users who buy their own cannabis do so in coffee shops, particularly in urban areas (Wouters & Korf, 2009). Those who acquire their cannabis in other ways or only make a short visit to coffee shops are harder to access. Therefore, snowballs were initiated in coffee shops, assuming that subsequent referral chains would emerge, which also include non- and less frequent coffee shop visitors.

To recruit respondents we adopted a stepwise model developed by Watters and Biernacki (1989) and slightly revised by Korf (1995). This model can be
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divided into four stages: (1) ethnographic mapping and preparation (2) finding and interviewing the first respondents (3) initiating snowballs and referrals and (4) quality control.

Ethnographic mapping and preparation
Except for one city (Alkmaar), where all local coffee shops were used for recruitment, an ethnographic mapping was conducted to select coffee shops suitable for recruiting respondents in Amsterdam, Utrecht, Nijmegen, and Arnhem. Selection criteria for coffee shop recruitment sites included those mainly visited by Dutch-speaking cannabis users (in particular because we did not want to recruit foreign tourists into the study), diversity of visitors (i.e. ethnicity, sex, age), and geographical spread over the city. From March to August 2008, dozens of coffee shops were repeatedly visited, on different days, and at different times during the day. From every visit, field notes were made regarding the number and diversity of visitors observed, and of informal conversations with staff and visitors. Informal conversations with staff also aimed to gain permission to recruit customers into the study. Throughout this intensive ethnographic mapping, we selected 28 coffee shops for recruiting respondents: 12 in middle-sized cities (2 in Arnhem and 5 in Nijmegen, both in the East of the Netherlands; and 5 in Alkmaar in the North-West), with both urban and rural visitors; and 16 in large cities (5 in Utrecht and 11 in Amsterdam). Only one selected coffee shop refused to participate.

Interviewing first respondents
Zero-stage respondents are not necessarily representative of the target population (Wang et al., 2005). In the selected coffee shops we approached customers within the age range of our target population. All candidates were screened before the final interview using a short selection schedule containing items both relevant and irrelevant to participation. Most non-responders were too busy, while most excluded candidates were over 30 years of age, or had used cannabis less frequently than three days per week in past 12 months. Once included, an appointment was made for the interview. All interviews took place at a quiet location: mostly at respondent’s home or at the research institute and sometimes in a quiet cafe, public library, or coffee shop. At zero stage, two researchers and three field assistants, all trained in conducting fieldwork and CIDI interviews, interviewed 200 respondents.

Initiating snowballs and referrals
Once interviewed successfully, respondents were asked to assist in the recruitment of other frequent cannabis users, thus generating referrals (“Do you personally know other frequent cannabis users who might want to
participate in our study?”). Respondents were asked to call potential respondents they knew personally, preferably immediately after the interview, or let them contact the interviewer, thus playing an active part in the recruitment process. Respondents received vouchers with the contact details of the interviewer to give to new respondents and financial compensation of 7.50 euro for each successful referral, up to a maximum of three (cf. Heckathorn, 2002). We monitored who recruited whom and so could link referring respondents with their referrals.

Quality control
To ensure the inclusion of qualified candidates, potential respondents, both zero-stage and referrals, were screened. When candidates did not meet inclusion criteria, they were simply informed that they were not eligible for the study, without further specification. We did so in order to protect our screening data from becoming known to future candidates. During data collection, the quality of the data and sample characteristics were periodically controlled. Since non-dependent frequent cannabis users were more prevalent than expected, it was decided to extend the sample beyond the originally planned size of 550. Regarding diversity, we aimed at 15-25% females and 15-25% ethnic minorities (no normative data available), and we periodically checked and made adaptations if needed. For example, we adapted the recruitment strategy by targeting more females at zero stage. Finally, 16 of the originally 616 respondents were excluded from the study because of the dubious quality of the interview data (e.g. unreliable inconsistent answers) or repeated participation.

Analysis
The statistical package SPSS 15.0 was used to perform analyses. Regarding cannabis-use characteristics, the following variables were entered into the analyses: setting of use (in home settings, coffee shops, and other, including nonselective/everywhere); frequency of cannabis use (near-daily vs. less than near-daily); use cannabis (also) on weekdays vs. on weekends only; number of joints smoked per day of use; use (also) in the daytime (yes/no); use when alone (yes/no); preference for marijuana, for hashish, or no preference; and mean age of onset of frequent cannabis use (defined as at least once a month). All cannabis-use characteristics referred to the last month.

Sociodemographic variables included in the analysis were: sex; age (years); ethnicity (measured by country of birth of parents and respondents, and dichotomized into Western vs. non-Western (cf. Benschop, Harrison, Korf, & Erickson, 2006); employment status (student, employed, and unemployed);
and education (none/basic vocational, secondary lower, secondary higher, and higher professional education).

First, Chi2 for categorical data and Mann-Whitney U tests (because variables had a nonnormal distribution) for continuous data were used to compare seeds vs. loners, and network members vs. loners on the DSM-IV diagnosis of 12-months cannabis dependence, cannabis use characteristics, and sociodemographic variables (Table 2.1).

Second, Pearson r was used to assess correlations between network size, cannabis use, and sociodemographic variables (not in Table).

Third, to investigate whether characteristics of seeds are associated with the prevalence of last-year cannabis dependence in referrals and social networks, we performed Chi2 (not in Table). Next, Chi2 was applied to explore whether cannabis users in larger networks differed from each other, in addition to or apart from cannabis dependence (Table 2.2). To further investigate what unites members of a network and distinguishes them from members in other networks, discriminant analyses (Klecka, 1980) were conducted. Since the literature did not provide a strong rationale for preferring one set of potential discriminating variables over the other, we performed enter discriminant analysis to identify the most constructive and least redundant set of cannabis-use characteristics associated with network membership. In addition, sociodemographic variables were included in the analysis (Table 2.3).

Discriminant analysis was performed in two steps: (a) F test (Wilks’ lambda) if the discriminant model as a whole was significant, and (b) if F test proved significant, then individual independent variables were assessed to investigate which variables differed significantly in mean by group. Wilks’ lambda (λ) value ranges from 0 to 1.0, whereby small values indicate strong group differences and value 1 signifies no differences (SPSS, 1999). For each analysis, Wilks’ lambda and the canonical correlation coefficient (R*) were considered to investigate the variance of group membership explained by the discriminant function. R* measures the association between the groups formed by the dependent and the given discriminant function (SPSS, 1999), and investigates how much each function is useful in determining group differences. When R* is 0, there is no relation between the groups and the function. Chi2 was used to test whether the discriminant function discriminates the groups better than expected by chance. All variables were standardized into Z-scores before entering the discriminant analysis, to equal the weight of variables with different scale measures. Finally, by a qualitative visual inspection, we explored clustering of cannabis dependence within larger social networks (Figure 2.1).
Unless mentioned explicitly, only statistically significant differences or associations are reported. Differences were considered significant for a two-tailed p-value < 0.01. The significance level was set lower than the more common p < 0.05 because of multiple comparisons and the large sample size.

**Findings**

**Sample**

Sample characteristics are presented in Table 2.1. The vast majority (79.3%) of respondents were male. The mean age was 22.0 years (SD 3.1). Three quarters (71.8%) were of Western origin. Most respondents were employed or students and 14.8% were unemployed. One third had achieved or was attending a higher professional education. The mean age of onset of frequent use (> 1/month) was 15.5 years. Approaching half of all participants (42.0%) met DSM-IV criteria for cannabis dependence in the 12 months prior to the interview. Two thirds used cannabis near-daily. Over one third used cannabis (also) during the daytime, and the majority (also) on weekdays. Less than one quarter commonly used cannabis when alone. Two thirds used cannabis mostly or exclusively in home settings, 17.5% in coffee shops and the remainder in other or various (including anywhere) settings. Most respondents had a preference for marijuana (62.2%), 29.7% for hashish and 8.2% had no clear preference for either. As is common practice in Europe (EMCDDA, 2008), almost all respondents (99.5%) mixed their cannabis with tobacco in a joint. The mean number of joints smoked per day of use was 3.4 (range 1-20).

From the 200 zero-stage respondents, 70 successfully referred to other respondents (seeds) and 130 did not (loners). The remaining 400 respondents were recruited by either referring seeds (at first stage) or other referring respondents (at subsequent stages). Cannabis-use-related networks of respondents (= both seeds and referrals) varied in length of chains and in number of waves. Of the 70 networks, 18.1% consisted of two or three respondents, or one or two waves. The largest network comprised 13 waves, and 61 respondents. The mean network size (excluding loners) was 18.9 respondents.

Regarding the first research question, whether loners differ from seeds with referrals and from network members regarding cannabis dependence, cannabis use, and sociodemographic characteristics, loners were less likely to be students or employed than seeds. Loners and seeds did not differ in last-year cannabis dependence or in other cannabis use characteristics (Table 2.1).
### TABLE 2.1
Demographic and cannabis use characteristics of sample (n = 600)

<table>
<thead>
<tr>
<th></th>
<th>Total (n=600)</th>
<th>Loners (n=130)</th>
<th>Seeds (n=70)</th>
<th>Loner vs. seeds (p) *</th>
<th>Network members (n=470)</th>
<th>Loners vs. network members (p)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20.7%</td>
<td>22.3%</td>
<td>17.1%</td>
<td>.391</td>
<td>20.2%</td>
<td>.602</td>
</tr>
<tr>
<td>Mean age, in years (SD)</td>
<td>22.0 (3.1)</td>
<td>23.1 (3.4)</td>
<td>22.3 (3.6)</td>
<td>.057</td>
<td>21.7 (2.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Non-Western ethnicity</td>
<td>28.2%</td>
<td>33.1%</td>
<td>28.6%</td>
<td>.515</td>
<td>26.8%</td>
<td>.176</td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>43.7%</td>
<td>28.5%</td>
<td>54.2%</td>
<td>&lt;.001</td>
<td>47.9%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Employed</td>
<td>41.5%</td>
<td>50.0%</td>
<td>40.0%</td>
<td>.176</td>
<td>39.1%</td>
<td>.029</td>
</tr>
<tr>
<td>Unemployed</td>
<td>14.8%</td>
<td>21.5%</td>
<td>5.8%</td>
<td>.001</td>
<td>13.0%</td>
<td>.031</td>
</tr>
<tr>
<td>Education (achieved or attending)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None/basic vocational</td>
<td>9.2%</td>
<td>9.2%</td>
<td>7.1%</td>
<td>.616</td>
<td>9.1%</td>
<td>.977</td>
</tr>
<tr>
<td>Secondary lower</td>
<td>20.5%</td>
<td>26.9%</td>
<td>20.0%</td>
<td>.266</td>
<td>18.7%</td>
<td>.058</td>
</tr>
<tr>
<td>Secondary higher</td>
<td>37.5%</td>
<td>37.7%</td>
<td>37.1%</td>
<td>.939</td>
<td>37.4%</td>
<td>.959</td>
</tr>
<tr>
<td>Higher professional (academic)</td>
<td></td>
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<tr>
<td>Cannabis use</td>
<td></td>
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<tr>
<td>Last year cannabis dependent</td>
<td>42.0%</td>
<td>35.4%</td>
<td>40.0%</td>
<td>.521</td>
<td>43.8%</td>
<td>.080</td>
</tr>
<tr>
<td>Mean age of onset frequent use (SD)</td>
<td>15.5 (2.2)</td>
<td>15.6 (2.3)</td>
<td>15.5 (2.3)</td>
<td>.666</td>
<td>15.4 (2.1)</td>
<td>.443</td>
</tr>
<tr>
<td>Near-daily cannabis use</td>
<td>68.4%</td>
<td>79.2%</td>
<td>72.5%</td>
<td>.233</td>
<td>65.3%</td>
<td>.001</td>
</tr>
<tr>
<td>Smoking cannabis on weekdays (also)</td>
<td>84.5%</td>
<td>89.2%</td>
<td>90.0%</td>
<td>.866</td>
<td>83.2%</td>
<td>.063</td>
</tr>
<tr>
<td>Smoking cannabis at daytime (also)</td>
<td>37.8%</td>
<td>43.1%</td>
<td>41.4%</td>
<td>.823</td>
<td>36.4%</td>
<td>.173</td>
</tr>
<tr>
<td>Mostly using cannabis alone</td>
<td>21.5%</td>
<td>35.4%</td>
<td>21.4%</td>
<td>.033</td>
<td>17.7%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Setting of cannabis use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-selective (everywhere)</td>
<td>18.2%</td>
<td>13.8%</td>
<td>18.6%</td>
<td>.742</td>
<td>19.4%</td>
<td>.141</td>
</tr>
<tr>
<td>&amp; other</td>
<td>64.3%</td>
<td>49.2%</td>
<td>54.3%</td>
<td>.498</td>
<td>68.5%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Home settings</td>
<td>17.5%</td>
<td>36.9%</td>
<td>27.1%</td>
<td>.155</td>
<td>12.1%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Coffee shops</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Preference for</td>
<td></td>
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</tr>
<tr>
<td>Marihuana</td>
<td>62.2%</td>
<td>68.5%</td>
<td>58.6%</td>
<td>.172</td>
<td>60.4%</td>
<td>.087</td>
</tr>
<tr>
<td>Hashish</td>
<td>29.7%</td>
<td>27.7%</td>
<td>34.3%</td>
<td>.334</td>
<td>30.2%</td>
<td>.578</td>
</tr>
<tr>
<td>No preference</td>
<td>8.2%</td>
<td>3.8%</td>
<td>7.1%</td>
<td>.353</td>
<td>9.4%</td>
<td>.011</td>
</tr>
<tr>
<td>Mean joints per day (SD)</td>
<td>3.4 (2.2)</td>
<td>3.4 (2.4)</td>
<td>3.6 (2.4)</td>
<td>.549</td>
<td>3.4 (2.2)</td>
<td>.991</td>
</tr>
</tbody>
</table>

* Including both seeds & referrals
* * p ≤ .01 in bold
Compared to network members (seeds and referrals), loners were more likely to use cannabis near-daily, to use cannabis alone, and in coffee shops, but less likely to use cannabis in home settings. Loners were older, and likely to be students than network members (Table 2.1).

To assess the second research question, whether smaller chains differ from larger chains regarding cannabis dependence, cannabis use and sociodemographic characteristics, correlations were examined between demographic and cannabis use variables and network size (number of seeds and referrals, ranging from 2 to 61). Only using cannabis in coffee shops was significantly correlated ($r = -0.134$, $p = 0.002$) with network size: use in coffee shops was more often found in smaller networks. Other demographic or cannabis use variables showed no significant correlation with network size (not in Table).

Concerning the third research question (do characteristics of seeds with referrals predict the prevalence of last-year cannabis dependence in referrals and social networks?) cannabis dependence among seeds was compared with wave 1 referrals and with total resulting network (all waves). Of the 70 seeds, 28 were classified as last year cannabis dependent (40.0%). Dependent and non-dependent seeds recruited in the first wave on average had similar numbers of respondents (1.6 vs. 1.8, $p = .349$). They also had similar percentages of dependent referrals, both at wave 1 (45.0% vs. 44.0%, $p = .792$) and in the total network (53.2% vs. 39.0%, $p = .092$) (not in Table).

To explore selection mechanisms and/or binding factors in cannabis-use-related social networks of frequent cannabis users (fourth research question: what are the defining factors in social networks of frequent cannabis users, in addition to or apart from cannabis dependence?), we analysed differences between the four largest networks in our sample. A cut-off point of 20 respondents in a network was chosen for pragmatic reasons but also to minimize bias and reduce the influence of outliers. The size of these four networks varied from 20 to 61 respondents, with a total size (including the seeds) of 144 (i.e. 24.7% of all participants in the study) (Table 2.2). Again, location of cannabis use (coffee shops) was the only significant difference between these four networks. To further investigate what unites members of a network and distinguishes them from those in other networks, discriminant analyses were conducted. As we found very few differences between the largest networks, we compared each of the four largest networks one-by-one with all other network members in the total sample ($n = \text{total network members (470)} - \text{number of respondents in a particular larger network}$; for network 1, $n = 470-61 = 409$; for network 2, $n = 470-34 = 436$, etc.). Table 2.3 shows discriminant analysis predicting network
Cannabis dependence and peer selection

Only the members of network 1 were significantly different from other network members in terms of their location of cannabis use; they were less likely to use cannabis at coffee shops ($F = 14.71, p < .0001$), but more likely to use cannabis in various other settings ($F = 9.78, p = .002$) than other network members. Table 2.3 also shows that cannabis use characteristics account for only a very small percentage of the variance (3-8%) between each of the largest four networks and all other network members. Therefore, additional analyses were required to determine other variables that better classify network membership.

Consistent with the exploratory nature of this article, we tested whether sociodemographic characteristics could account for better discrimination between each network and the other network members. Therefore a second discriminant analysis was performed. This time, three networks differed significantly and the discriminant functions were significant (Table 2.3).
Network 1 and 3 members were more likely to be female (F = 9.95, p = .002 and F = 14.46, p < .0001), whereas network 2 members were more likely to be male (F = 6.96, p = .009). Also, members of network 2 (F = 8.78, p = .003) and network 4 (F = 9.83, p = .002) were more likely to have a higher education and network 3 members were more likely to have no/a basic vocational education (F = 17.97, p < .0001). Network 3 members were more likely to be non-Western (F = 55.24, p < .0001).

Finally, subsequent discriminant analysis was conducted with both cannabis use variables and sociodemographics, again comparing each larger network one-by-one with all other network members. The discriminant function was significant only for network 1 and 3. No new significant variables emerged. The structure matrices identified sociodemographic variables as the most discriminating except for network 1. The most discriminating variable for each
network was: location of use (coffee shops) in network 1, (higher) education in network 2 and network 4, and ethnicity (non-Western) in network 3.

For all networks, network membership was best predicted by sociodemographics and cannabis-use characteristics together. Only for network 3, canonical correlation (.41, p < .001) indicated a quite strong discriminating function.

**Clustering within networks: Qualitative visual inspection**

Our previous analyses indicate that cannabis dependence and cannabis-use characteristics do not seem to play an important role in social inclusion into or social exclusion from social networks of frequent cannabis users. For example, discriminant analysis revealed that only network 1 members were different from other network members by cannabis-use characteristics (i.e. location of cannabis use). This leaves us with the question whether cannabis dependent users cluster within social networks, or whether they are more or less randomly distributed. We explored this question by visual inspection of the largest networks, and focused on the distribution of cannabis dependence and sex. In addition, we looked at age, employment status, level of education, and ethnicity in these networks. Figure 2.1—made with Netdraw software for social network analysis (Borgatti, 2002)—shows the distribution of current (last 12 months) DSM-IV cannabis dependence and sex of all respondents represented in the four largest networks.

Network 1 (n = 61) started with a male non-dependent seed, and 35 respondents were classified as last-year cannabis dependent. At first sight, cannabis-dependent users are rather randomly spread over this network. At closer look, 19 of the 35 cannabis-dependent users are located at the end of a (sub) chain, and did not successfully refer to new respondents. However, 13 of the 26 non-dependent users in the network are also located at the end of a (sub) chain. Consequently, this does not allow for a strong conclusion regarding social exclusion or differential inclusion. Nonetheless, Figure 2.1 suggests some degree of clustering of dependent users within the total network, as is most clearly illustrated by the network 1 segment at the top, left-hand side, with 8 out of 10 respondents being dependent, while the remaining 2 non-dependent respondents are part of short subchains. However, when looking at sex of respondents, it could easily be argued that in this example, being female is the “feather” that makes these dependent users flock together, since all but one dependent respondent in this segment are female, while only one non-dependent user is female.
Network 2 (n = 34) started with a male non-dependent seed and was comprised of all but one male respondents. From 16 cannabis dependent network members, 9 were located at the end of (sub) chains. The other dependents in the network are concentrated in a subnetwork around one non-dependent male, but their referrals continue to non-dependent respondents.

FIGURE 2.1
Distribution of last year cannabis dependence and sex in four largest networks (including both seeds & referrals)

In network 3 (n = 29), starting with a dependent male seed, we observed a rather random scattering of cannabis dependence within the network. Only 2 of 11 cannabis dependent users in this network are situated at chain ends. Although there is some clustering of cannabis dependent respondents in one subchain (top, left), sex appears to be the stronger selection mechanism, with 10 waves of female referrals from the female seed onwards, and males only at the end of (sub) chains plus one subchain of 9 males.

Network 4 (n = 20) is the only one with most cannabis dependent users located at chain ends (5/6). Except for the female (non-dependent) seed, this network has only male respondents.

From this visual inspection, no consistent pattern evolves regarding the role of cannabis dependence in social exclusion or differential inclusion within the social networks of frequent cannabis users. Possible patterns seem to be associated with sex of respondents. Further inspection reveals that age does
not offer alternative explanations, since this variable is rather randomly distributed in the four larger networks (data not shown). Two other sociodemographic characteristics (ethnicity and employment status) reveal some patterns. In network 1, non-Western participants largely cluster in subchains but no association is observed with cannabis dependence. There were also some subchains of mostly students, and most of them were cannabis dependent. Network 2 represents a mix of Western and non-Western respondents and we found no association between ethnicity and dependence. Also, this network has a mixture of respondents who are students, employed, and unemployed. The only pattern we found was that all students in this network were dependent. Network 3 is almost exclusively non-Western, with about half of respondents being employed. No employed respondents in this network were cannabis dependent, while 4/5 students and 5/6 unemployed were. Only 2/20 members of network 4 are non-Western, and most respondents were students. We found no association between cannabis dependence and employment status.

In conclusion, the role of cannabis dependence as a defining group member factor appears twofold: on the one hand, we observed dependent users often being located at the end of (sub) chains, while on the other hand sub networks of dependent users congregated within the largest networks, but were not isolated from non-dependent users. In addition, in network 1 and 3, respondents showed some clustering around sex and employment status. We found variation in ethnicity between networks, but visual inspection revealed no consistent association between ethnicity and cannabis dependence within networks.

Discussion
The purpose of this study was to explore selection and uniting processes among frequent cannabis users in social networks. We interviewed a large sample of 600 frequent cannabis users, and 42.0% of this was diagnosed as DSM-IV 12-month cannabis dependent.

In line with Zinberg’s theory, we hypothesized that loners would be more likely than seeds and network members to be last-year cannabis dependent, when interpreting no referrals/ not referred as indicators of social exclusion. From a similar perspective, we hypothesized that respondents in smaller networks would more likely be cannabis dependent than those in larger networks. These hypotheses were neither confirmed nor solidly refuted by the data. The finding that network members and seeds were more often dependent than loners indicates that the notion of social exclusion by uncontrolled use does not apply to a population of frequent cannabis users.
only. Our findings tend to support our alternative hypothesis: frequent cannabis use by itself is a violation of social norms regarding controlled use, and therefore dependence does not catalyse social exclusion from frequent but non-dependent users. Although visual inspection of larger networks showed no comprehensive random distribution of cannabis dependence, we did find some degree of clustering of cannabis dependent users within networks. This suggests some level of differential inclusion of cannabis dependent users: they are not fully socially excluded from/by other cannabis users, but tend to flock together as subgroups within social networks of frequent but non-dependent users. Within the context of the social networks of cannabis users in the Netherlands, our findings provide further evidence that RDS sample characteristics are independent of the characteristics of the seeds and that RDS recruitment may relate to several other factors.

Our assumption that seeds that are not productive or generative (in our study defined as loners) are socially excluded is debatable. A participant may not recruit others into the study for different reasons independent of their position in the network (e.g. the individual they refer to may not wish to participate). In addition, network size (in our study measured as number of successful referrals) might not be an appropriate indicator of social inclusion. We did not find an association between length of network chains and social exclusion. According to Uusküla et al. (2010) the size of participants’ social network is not significantly associated with the number of persons recruited into an RDS study. Reisner et al. (2010) found that network size alone was not significantly associated with generative seeds, suggesting that other factors (e.g. network density) must be taken into account as well.

The extent to which respondents successfully refer to other respondents might also vary between target populations. For example, Uusküla et al. (2010) found that RDS was far less effective among female sex workers (FSWs) than among injecting drug users (IDUs). In their IDU study, five seeds were enrolled (100% productive, measured as recruiting at least one person into the study) and in the FSW study, 26 of 43 seeds (60%) successfully recruited other participants. According to the researchers, the lower effectiveness of RDS among female sex workers was due to interference by gatekeepers (i.e. madams at the brothels, pimps) who hindered referrals from participating. However, we have no reasons to believe that this specific problem applies to our study, since we had free access to coffee shop visitors and thus did not depend on such gatekeepers. In our study, 70 of 200 seeds (35%) were productive (defined as recruiting at least one other person). This is line with Reisner et al. (2010), who had 34% generative seeds (defined as
recruiting at least two other persons) in their sample of men who have sex with men.

The context of cannabis availability and acquisition and its legal status in the Netherlands is likely to have an important effect on some of our findings. Mainstream community acquisition of cannabis will potentially affect the social marginalization (or lack thereof) compared to other countries where users need to obtain cannabis through dealers and illicit channels—especially for dependent users that will need to establish and maintain connections with these potentially marginalized dealer networks. Consequently, it may well be that our assumptions regarding loners as productive seeds would hold in other contexts.

In conclusion, cannabis dependence versus non-dependence does not appear to be the “feather,” the major binding factor in cannabis-use-related social networks of frequent cannabis users. The same holds for other cannabis use characteristics: with whom, where, and when cannabis is used play a role, but not a decisive one. In addition, sex, ethnicity and employment status played some role in structuring larger social networks, but did not make a strong difference in explaining the discrimination of particular networks from others. This is not to say that processes of social inclusion and exclusion are absent in networks of frequent cannabis users. Future research might reveal other variables than those included in this study: for example, other lifestyle characteristics, the use of drugs other than cannabis, personality, or motives for using cannabis. For the current article, only data from baseline were available, and only allowed for cross-sectional comparisons regarding social networks. The longitudinal character of our study will allow analysis of changes over time.

Obviously this study has some limitations. First, we explored peer associations by considering chains of respondents as social networks. However, these networks were restricted to cannabis users. Moreover, only frequent cannabis users were included in the study and consequently in the networks, while in fact respondents may have had much more varied social networks, including less frequent cannabis users and nonusers. Similarly, our definition of loners does not mean as such that they are not embedded in social networks of cannabis users or others.

Second, in our methodology we applied various aspects of RDS, for instance a dual-incentive system for participating and for recruiting other participants (Salganik & Heckathorn, 2004), as well as flexibility regarding location and time of the interview (Uusküla et al., 2010). However, it might well be argued that we did not use RDS in its pure form, since we did not collect data
concerning the network size of individual respondents, which is essential for standard RDS analysis regarding homophily and statistical validity for population estimates (Salganik & Heckathorn, 2004). However, the collection of such data would have required asking respondents how many frequent cannabis users they knew and how many of them were dependent. Although frequency of use of others might be reliably estimated by the respondent, dependence (and therefore non-dependence as well) is unlikely to be reliably assessed by participants. Network size could therefore not be determined.

Heckathorn, Broadhead, Anthony, and Weakliem (1999) imply that seeds rarely fail and only a limited number of seeds are required to generate samples of many hundreds of drug users, with high levels of heterogeneity. However, in our study a substantial number of zero-stage respondents were required to recruit a sample of 600 frequent cannabis users. This raises the question whether frequently reported experiences with RDS in studies among frequent hard drug users—often IDUs—and defined as marginalized problem users (cf. Abramovitz et al., 2009; Burt, Hagan, Sabin, & Thiede, 2010; Wattana et al., 2007) are more generally applicable to various populations of drug users and to other groups. Nevertheless, and most interestingly, within the population of frequent cannabis users, we did find a rather heterogeneous total sample as well as heterogeneity within social networks, both in terms of cannabis use characteristics and sociodemographics.

An important consequence of our study for prevention and treatment is that cannabis dependence is not a key factor in social networks of frequent cannabis users in the Netherlands. In the practice of targeted prevention the concept of dependence might not be very relevant.